VOL. 38, NO. 3 MARCH, 1961

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Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION, 1508 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

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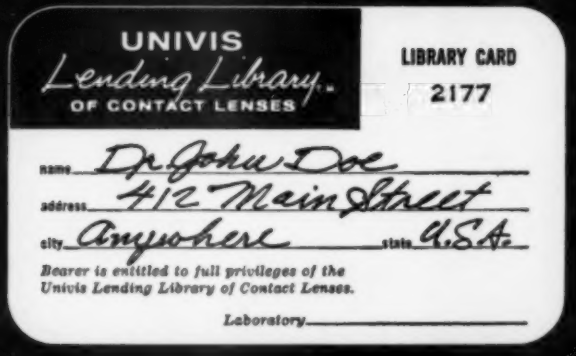

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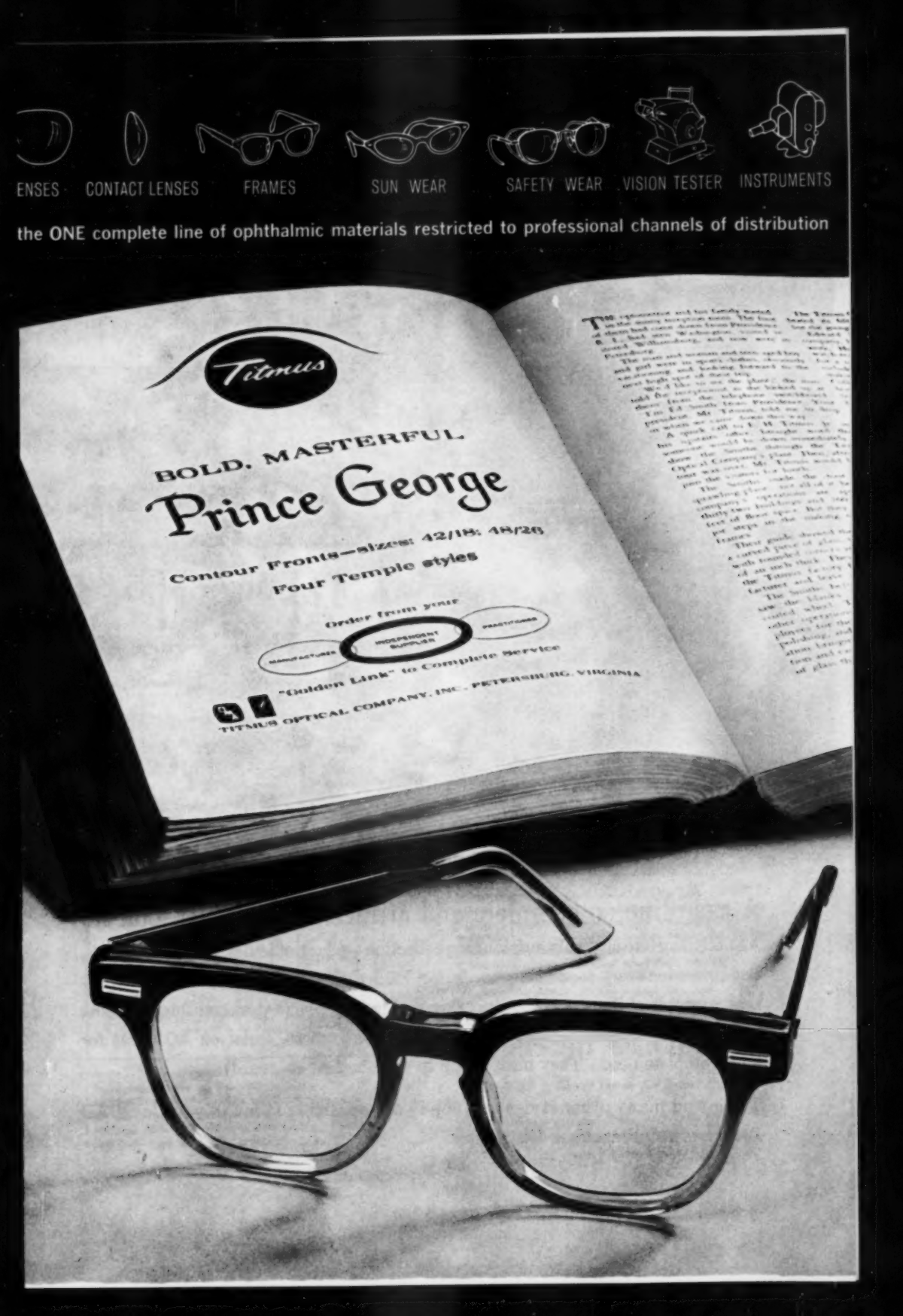
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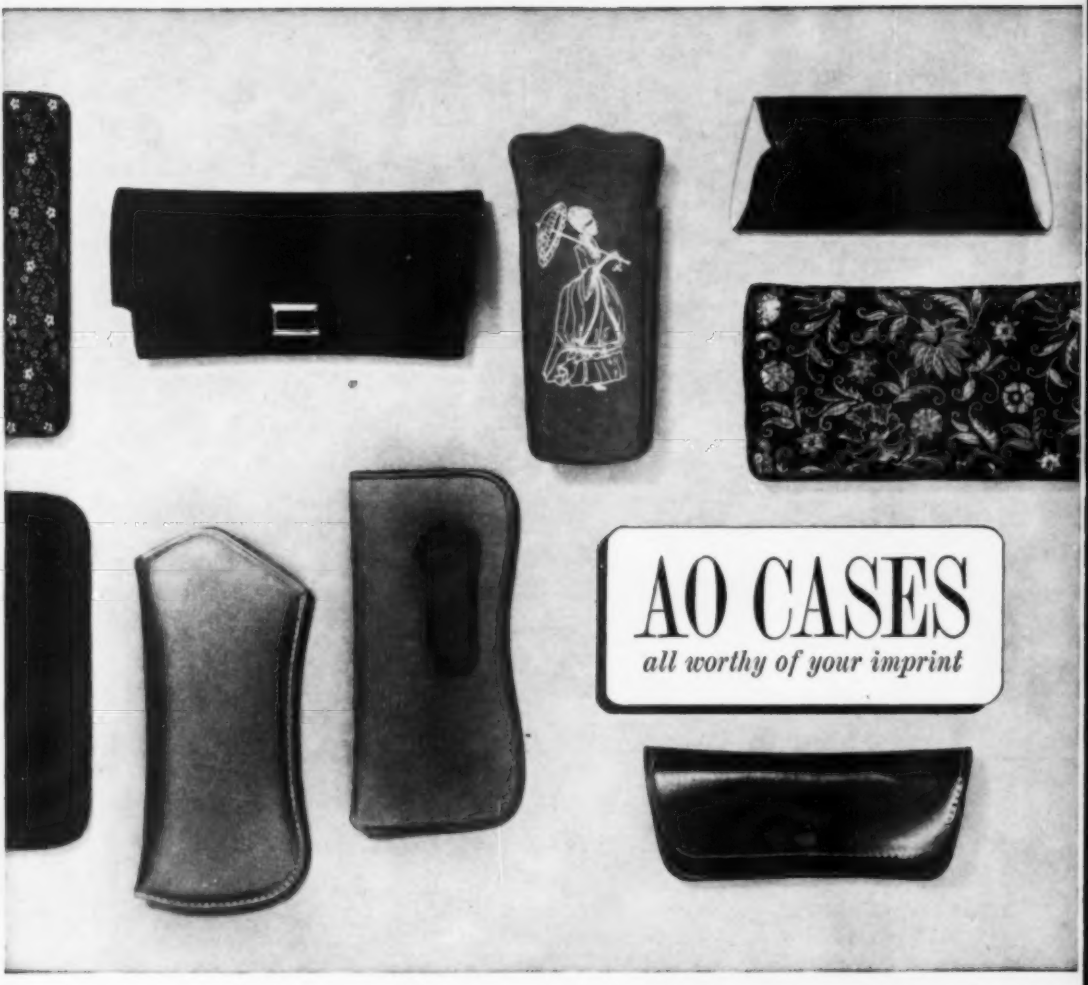

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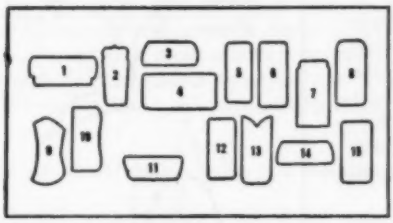

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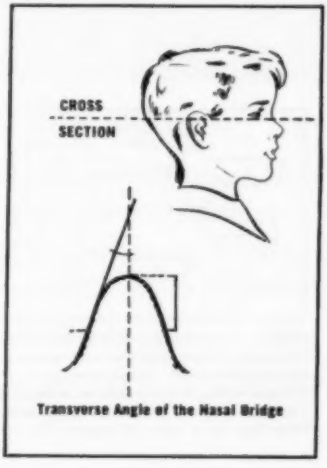
Three basic methods were applied to the compilation of this data: (1) Authoritative anatomical studies and subsequent recommendations were made at three of the nation's leading universities. (2) Personal interviews with practitioners and distributors in 12 major cities. And, (3), parent interviews by the world famous Corning Research Center.

Several facts were found to be highly significant. In the 5 to 14 year age group, for example, there are presently 4,756,000 wearers. An annual demand (rapidly growing) of 3,711,000, due to new examinations and re-examinations combined, clearly shows that this age group presents us with a population segment that obviously merits more serious consideration.



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This discovery meant the need for an entirely new approach to bridge and pad designs for youngsters' frames; designs to overcome the many problems of fitting and patient comfort that face all practitioners. Interviews with suppliers and practitioners proved beyond question that existing products simply don't meet these and other needs;

Report:

that no optical manufacturer has, indeed, given the problem proper recognition. Lastly, parental attitudes reflect concern over styling, problems of breakage and weight, etc.

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Vol. 38 March, 1961 No. 3

ANOMALOUS CORRESPONDENCE INTERPRETED AS A MOTOR PHENOMENON*

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Of all the many theories proposed to account for anomalous correspondence there is one which can perhaps be called "classical" because its evolvement has had the longest continuous history and because it is accepted by more present day workers in the field of vision than any other. Burian has traced the development of this theory in his thesis published in 1947[1] and brought up to date in 1958.[2]

The essence of this "classical" theory can be summarized by quotations from these two papers by its most convincing advocate. The writer has made every effort to select these so that the ideas are correctly presented (in spite of the quotations being out-of-context).

"Corresponding retinal elements are those elements of the two retinas the stimulation of which, in binocular vision, gives rise to the localization in one and the same visual direction, no matter whether the stimulus reaches the retinal elements in one eye alone or the corresponding elements in the other eye alone or both simultaneously."[1a]

"It (anomalous correspondence) ** is essentially a faulty judgment of visual direction"[1b] in which there ". . . is an attempt of the organism to adopt the sensorial condition of the visual apparatus to the anomalous motor condition in an attempt at a restoration of the binocular cooperation."[1c]

According to Burian anomalous correspondence develops gradually and at first it is not evident for every viewing situation. If nothing interferes, the anomalous condition becomes more deep seated and becomes manifest at all times, under all conditions. "The anomalous sensorial relationship between the two retinas, the anomalous retinal correspondence, represents, thus a process of adaptation of the sensorial to the anomalous motor conditions; it consists in a shift of the visual directions

*Read before the annual meeting of the American Academy of Optometry, San Francisco, California, December 13, 1960. For publication in the March, 1961, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Professor of Physiological Optics and Optometry. Dean, School of Optometry, University of California. Fellow, American Academy of Optometry.

**Added by writer for sake of clarity.

of one eye relative to those of the other eye."[1d] (Note the implication of gradual development with time.)

"The manifold variations in the mode of relative localization by squinting patients finds a plausible explanation only in the theory of visual directions. Retinal correspondence is not anatomically but physiologically fixed. What is fixed is the directional localization in subjective space resulting from the excitation in a given cortical locus.* This locus can be reached from more than one retinal area. In normal binocular vision a given cortical locus may be fed excitations from a more or less restricted region, the region comprised within Panum's area. In strabismus this may be supplied by even more distant retinal areas. What path the stimulus is going to take may depend upon the thresholds at the synapses."[2a]

"There is undoubtedly simultaneous perception with anomalous correspondence. Bielschowsky has demonstrated that binocular color mixture may exist in such cases.** I was able to prove that there may be fusional movements with anomalous corresponding retinal areas, but the highest degree of binocular cooperation, stereopsis, is never achieved."[1e]

There are certain other attributes of anomalous correspondence which have been noted by Burian. ". . . the treatment of this condition is one of the most difficult problems in ophthalmology.† Even the most skillful application of all means at one's disposal leads to a permanent cure in only a relatively small number of cases."[1f] The condition appears stable since he remarks, "I have never observed gradual changes in the angle of anomaly."[1g] Whenever a change in the condition is achieved, it is apt to be dramatic. "Both Bielschowsky and, particularly Ohm, have paid attention to the post operative development of the retinal correspondence and have stated that squinting patients go through three stages after successful surgical treatment. In the first stage the correspondence is anomalous; in the second, there is rivalry between normal and anomalous correspondence and in the third, the normal correspondence is re-established."[1h] Changes do, however, occur in anomalous correspondence. "Certain patients with facultative divergent strabismus who have binocular fixation when the divergence is overcome by a convergence impulse see the after-images in the form of a

*If this is true, why can a foveally perceived object be seen to the right, left, up or down depending on eye position?

**The writer has reported a patient who demonstrated color mixture from two retinal areas in the same eye, see Morgan, M. W., A unique case of double monocular diplopia, Am. J. Optom. and Arch. Am. Acad. Optom., 32: 70-87, 1955.

†The writer would say, "amen" and adds optometry.

cross when they fixate binocularly. But when their eyes are dissociated they see the vertical after-image displaced to the right or left."[11]

Burian recognizes at least one major obstacle to this thesis that anomalous correspondence develops as an adaptation since he writes, "One of the stumbling blocks to the interpretation of anomalous correspondence in terms of an adaptive mechanism is the frequent occurrence of an unharmonious relationship. Such a relationship would seem to be of little use to the patients. I have interpreted it as indicating a more or less recent change in the angle of squint for which the reasons may or may not be known and to which the sensory system is as yet not adjusted. . . . Halldén[3] believes that the findings of an unharmonious relationship is an artifact elicited by unnatural test conditions. . . . Rønne and Rindziunski,[4] on the other hand, . . . think that in the development of an anomalous correspondence the angle of anomaly gradually increases until it finally reaches an amount equal to that of the angle of squint."[2b]

Since anomalous visual direction is the chief characteristic of anomalous correspondence, visual direction should be examined. The basic concepts associated with visual direction seem very straight forward and rather simple until analyzed critically. The most complete and detailed analysis of visual direction was published by Walls[5] in 1951.

He pointed out succinctly that there are really two separate concepts in "direction perception"—one which he terms oculocentric direction and the other egocentric direction. "When the eye is in the primary position, . . ., whatever is imaged on the fovea is seen 'straight ahead.' The directions of other objects are to the left, up, etc., in accordance with the locations of their representations in Area 17. Everything that is seen, is seen within an oculocentric field. The visual ego, the 'self,' is as if located at the perspective center of the eyeball, . . . The material on a television screen is organized not with reference to the location of the receiver, but with reference to the location of the camera. Area 17 is the screen, but the eye is the camera."[5a]

The relative oculocentric directions of objects are fixed. This can best be realized by developing an after-image, centered upon the fovea of an eye, with a configuration which can be identified with respect to up, down, right and left. Now if the eye is moved voluntarily, the relative or oculocentric directions of the up, down, left, right portions of the after-image do not change. The "up" portion always remains "up," the "down" remains "down," etc. The after-image as a whole moves with the eye to appear in different egocentric directions.

"If I cover one eye and turn the other eye up and down, successive objects imaged on the fovea are seen in successive egocentric directions although they have the same oculocentric direction. As the eye moves, no object seems to move, for its egocentric direction is constant. If, while the eye moved, an object imaged on the fovea remained imaged on the fovea, that object would appear as moving, even if the field were otherwise empty. Its oculocentric direction would be constant, but its egocentric direction would change continuously with, and 'proportional to' the eye movement."[5b]

The visual cortex is anatomically connected with oculocentric direction and not with egocentric direction. Stimulation of two separated elements in the visual cortex would result in the perception of two "lights" separated in space by an amount equivalent to the space between the stimulated elements. These two "lights" would appear to have certain oculocentric directions, and, with the eye still, certain egocentric directions. If the eye should be moved, and the same two elements restimulated, the two "lights" would maintain the same oculocentric directions as before, but now their egocentric directions would be different.

The classical experiment demonstrating Hering's law of the identical visual direction of the two foveas serves to point out certain restrictions concerning this identity which are frequently overlooked. This can best be demonstrated if a fiduciary mark which is near the eyes rather than fairly remote is used. The finger may be used. The observer should close one eye, say the left, put his finger about 10 to 15 cms. in front of his nose. By sighting over his finger he should locate a bright object two to three meters away which is in line with his finger. The finger and the object will have the same oculocentric direction and the same egocentric direction. The egocentric direction of both the finger and the object will be left-ward. Now the right eye is closed and the left opened. The finger is not moved and now the observer should find a second bright definite object beyond his finger which is in line with it. Here again the oculocentric direction is the same for both the finger and the object. The egocentric direction is the same for both also but now this direction is right-ward. Now if both eyes are opened and the tip of the finger fixated, there is no change in oculocentric direction but there is a dramatic change in egocentric direction, for now, the finger and both objects, which are really separated in space, seem to be in a straight-ahead direction. (Care should be taken to avoid suppression of the image of one object and the physiologic diplopia must be neglected.) This experiment indicates not identical visual direction, for obviously the

directions are different for each eye, but rather, that simultaneous (or nearly simultaneous) stimulation of the foveas of each eye results in a single egocentric direction when there is normal correspondence.

In the discussion above, it was pointed out that egocentric direction changes with voluntary movements of the eyes. Movement of the eyes, however, is not essential in order for egocentric direction to shift. In the case of the experiment described above a monocular right-ward direction combines with a monocular left-ward direction to give a straight ahead egocentric direction. Thus a change in egocentric direction can occur without the need for an eye movement.

A change in egocentric direction without eye movement is the chief characteristic of the oculogravic illusion.[6] This illusion is induced when an individual is subjected to acceleration using a human centrifuge. If a subject who is seated facing the center of a centrifuge fixating a collimated point source of light in a dark room is accelerated at the rate at which the centripetal force equals the force of gravity he will feel as though he were tilting smoothly and firmly backward. The fixated point source of light, formerly on the horizon, will appear to rise. Since this illusion seems to depend on vestibular stimulation, it might be argued that the eye would rotate downward, opposite to the apparent movement of the body. If this should occur the image of the light would be on the lower half of the retinas and would be displaced upward as described. Under these conditions the light should not appear sharp and clear since it would no longer be imaged on the fovea. Since the light will remain clear, some doubt as to eye movement exists.

If the above experiment is repeated after the development of foveal after-images, it will be found that the after-images are centered on the fixation light before the acceleration. During the acceleration this coincidence is maintained and the light and after-images rise together. Obviously the upward movement of the fixation light could not have been due to a downward rotation of the eyes since this would have resulted in a downward movement of the after-images.

Another illustration of a change in egocentric direction without eye movement and without change in body position is the Dietzel-Roelofs Phenomenon.[7] A small light is placed directly in line with one eye of an observer. Another light is located to the right of the first in an otherwise empty dark field. Now if the observer voluntarily fixates the light in line with his eye, it will appear to move to the left. This shift in position is thought to be induced by the voluntary effort the observer must make to keep his fixation from shifting to the right in order to see the second light better.

A similar perceptual shift occurs if a subject fixates a light in a dark room in line with his eye. Now if a second light to the right of the first is turned on, the fixated light will appear to shift to the left. If a third light to the right of the second is turned on, the fixated object will shift again to the left.

The evidence is likewise strong that not every eye movement results in a shift in egocentric direction. If an individual maintains fixation on an object while he turns his head or his body or both, the eyes must move opposite to the movement of the head or body and yet the fixated object and indeed every other object in the field remains in the same egocentric direction.

The effect of ocular movements on the perceived egocentric direction of after-images has been reported in numerous papers, one of the most recent being that of Urist.[8]* The various observations can be summarized as follows:

1. Voluntary version movements—the after-image moves with eyes.
2. Voluntary head movements with the eyes stationary—after-image moves with the head.
3. Induced nystagmus:
   a. vestibular—after-image moves in the direction of the first slow movement but does not oscillate back and forth with the eye movements. Fast component, a saccadic-like movement, does not alter position of after-image.
   b. opticokinetic—after-image moves in direction of first slow motion: apparent movement similar to that observed with vestibular nystagmus.
4. Voluntary convergence—after-image appears to be "straight ahead," and appears to decrease in size and to approach the observer. (This change in size and distance is not marked in an empty visual field.) Its location, however, is in the same egocentric direction.

It is simple to prove that this "straight aheadness" is not related to the interaction between two after-images, one in each eye. If an after-image is developed in one eye only and the other eye is occluded, the perceived image will be located straight ahead if the eye with the after-image is adducted by convergence and it will be located to the side (left if the after-image is in the right eye) if the eye is adducted the exact same amount by a version movement. Indeed the shift can be

*The interpretation by Urist of the observations is considered by most authorities to be incorrect but this does not affect the accuracy of the observations.

dramatic in a dark room when the experiment is performed by an individual with good voluntary control of his eye movements.

The apparent egocentric direction of an object imaged on the fovea of an eye thus appears to be dependent not only on the position of the eye but it also appears to be dependent on the innervational pattern to the extraocular muscles. This means that the perceived egocentric direction of an object in an otherwise empty visual field appears to depend on the integration of many types of both sensory and motor information: feedback information from proprioceptive sense organs of the muscles of the trunk, neck and probably the extraocular muscles themselves: information from the labyrinth concerning head position with respect to gravity and movement of the head: and information from the cortex (?) indicating what could be termed "intent position of the eyes." If the visual field is not empty, the visual images themselves contribute information to the integration mechanisms. Certainly man uses vision to aid in spatial orientation. It is beyond the scope of this paper to speculate as to the mechanism or location in the brain of this integration mechanism. It should be noted that it is the end-result of the integration and not the process which reaches consciousness. Some possible mechanisms have been discussed by Ludvigh[9, 10] in two papers published in 1952 and by Cogan.[11]

To sum up: There are ocular movements which result in the perception of a change in egocentric direction but there are also other ocular movements which result in no shift in egocentric direction. Again, there are conditions in which there are no ocular movements and yet egocentric direction appears to shift. The perceptual results seem to be dependent in part on whether the movement (or lack of movement) of the eyes was voluntary or involuntary, conjugate or disjunctive, or saccadic or smooth. Movements which result in the perception of a change in egocentric direction could be said to be "registered" while those which result in no charge could be said to be "non-registered."

The hypothesis that there are differences in the innervational patterns of various ocular movements is supported by recent investigations of these movements. It has been found, for example, that there are marked differences in velocity and acceleration of conjugate and disjunctive movements and saccadic and smooth following movements. An integrative process of some type which clearly has a visual space component is indicated by the appearance of "anticipatory" movements of the eyes which would not be predicted on the basis of the known reaction times for the various ocular movements.[12, 13]

In comitant strabismus, the eyes move together and for any constant

amount of accommodation and with any constant fixation distance, the angle of squint remains essentially constant for any direction of gaze and with either eye fixating. These factors of free movement and constant deviation have led to proposals that most comitant squints have an innervational rather than a mechanical origin. Accommodative esotropia, for example, is clearly innervational.

In 1945, Adler[14] proposed that the fundamental cause of esotropia, at least, is an abnormal convergence innervation and that this abnormal innervation "is due to an abnormal supranuclear source of tonus, for by its very nature the angle of squint (comitant) remains the same in all positions of gaze."[14a] He pointed out that the general function of cortical innervation is largely inhibitory and that when this inhibition is cut off in individuals with normal binocular vision, by alcohol or anoxia, a relative esophoria or esotropia develops. Thus the subcortical centers seem to initiate an innervational pattern of excessive convergence which is normally inhibited by cortical innervation.

This theory has been criticized because it does not account for the fact that some esotropes have a normal near point of convergence while others have a remote near point. If the concept of Maddox concerning the complex nature of convergence is combined with that of Adler, this objection is largely overcome. Esotropia could exist because of an interference in either tonic convergence or accommodative convergence or both. Excessive tonic convergence would result in an esotropia but if this were associated with a low accommodative convergence, the individual might have a normal or even a remote near point of convergence. Indeed, the individual might achieve binocular vision for near objects and if this should occur fusional convergence would become a factor in the strabismus.

Another and more complex innervational theory has been proposed by Keiner.[15] All children, according to Keiner, are born as potential squinters. Normally a process of "orthophorization," resulting from the normal development of optomotor reflexes, counteracts this potential. If there is a delay in, or interferance with, normal development, strabismus may result. The optomotor reflexes according to Keiner are conditioned reflexes which utilize the efferent or "centrifugal" portions of innate reflex arcs. Keiner stated that the innate reflexes are the proprioceptive and the vestibular. Retinal activity occurring at birth initiates the development of three conditioned reflexes: namely, (1) A monocular duction reflex grafted onto the proprioceptive. (2) A binocular version reflex grafted onto the vestibular, and (3) A convergence reflex grafted onto the proprioceptive.

Keiner based his theory on earlier proposals of Zeeman and on his own investigation of the ocular movements of infants. He interpreted his observations to mean that Hering's law of equal innervation does not apply to the newborn: in fact, Hering's law is dependent on normally developed optomotor reflexes. Convergent strabismus results whenever there is a predominance of monocular adduction.

These two innervational theories, those of Adler and Keiner, have been presented, not because the writer necessarily believes that our present knowledge concerning comitant strabismus supports either or both but because they illustrate the possibility that comitant strabismus of innervational origin could be due to a variety of causes involving one or more different innervational patterns.

It has already been pointed out that the apparent egocentric direction of a perceived object, whether it be a real one in space or an after-image, depends not only on the position of the eyes but also on the innervational pattern which moved the eyes. (It should also be remembered that an ocular movement is not essential for the induction of a change in egocentric direction.)

Suppose that a particular individual has an esotropia solely as a result of excessive innervation to convergence. Now if the state of correspondence were tested in this individual by means of the Hering after-image test, normal correspondence would be expected since convergence innervation usually does not result in a change in egocentric directionalization. On the other hand suppose a patient has a left esotropia resulting from an interference with the normal version mechanism, such as monocular adduction proposed by Keiner. Now if the Hering after-image test were utilized, the after-image seen by the right eye would appear to coincide with the fixation object. The apparent egocentric direction of the after-image of the left eye would be shifted to the right since a version movement usually results in an altered egocentric direction and hence the test would reveal anomalous correspondence. If the misalignment of the eyes were due solely to monocular adduction the anomalous correspondence would be harmonious.

Thus anomalous correspondence might depend not on a sensory adaptation to a squint but rather on whether the basic underlying innervational pattern to the extraocular muscles was one which "registered" itself in consciousness as altering egocentric direction or whether the pattern was one which was "non-registered" in consciousness as altering egocentric direction. The innervation pattern would not need to be exclusively one or the other but could be partly "registered" and partly "non-registered." If the deviation were due entirely to a "non-regis-

tered" innervation, normal correspondence would result; if it were due entirely to a "registered" innervation, harmonious anomalous correspondence would result; and if it were due partly to a "registered" pattern and partly to a "non-registered" pattern, unharmonious correspondence would result.

It might be supposed that anomalous correspondence would be most prevalent in squints which developed early in life if Keiner's observations about monocular adduction and Hering's law are correct. On the other hand, if anomalous correspondence develops as a result of sensorial adaptation, the length of time that a squint had existed should be the important factor. Normally these two factors, early onset and the number of years over which the squint has existed, would be related. Thus both theories are consistent with the clinical evidence concerning the correlation of age of onset of a squint and anomalous correspondence.

If anomalous correspondence results from the type of motor innervational pattern, it should be possible to identify some types of strabismus which are not associated with anomalous correspondence. Clinical evidence[16] indicates that esotropic individuals with accommodative squint rarely develop anomalous correspondence even when the deviation has been present for a long time. Since accommodative squint actually results from excessive accommodative-convergence which appears to be a "non-registered" innervation pattern, normal correspondence would be expected on the basis of an innervational theory. Two different explanations are given for this low incidence rate of anomalous correspondence by the adherents of the sensorial adaptation theory: 1.) The angle of squint is more variable in accommodative esotropia than in other types, and 2.) The onset occurs later in life than in other types of deviations. It is true that for any fixation distance, the angle of deviation is more variable in accommodative esotropia than in other types but the angle of few squints is constant for various fixation distances. Consequently if squint angle variability can act to prevent sensorial adaptation in accommodative strabismus, it should be expected that angle variability would prevent adaptation in other cases. As a matter of fact only squinters with an AC/A equivalent to their P.D. would be expected to develop anomalous correspondence. The data of Flom[17] do not indicate any significant correlation between anomalous correspondence and the AC/A ratio.

Adler and Jackson[16] found that there is indeed a difference in the age of onset of accommodative squints and squints with anomalous correspondence. They also found, however, that 40 per cent of all esotropia that became manifest before the age of one year was accommodative

esotropia. Certainly there must be some other factor than late onset which prevents the association of anomalous correspondence and accommodative esotropia.

Halldén[3] has noted that there was co-variation of the objective angle of squint and the angle of anomaly in most of the squinters he studied. Normally* the angle of anomaly is stated to be the difference between the objective and subjective angles, thus:

$$A = O - S$$
$$\text{or } S = O - A$$

If angles O and A co-vary exactly, each angle would change by an amount, k

$$S = (O + k) - (A + k)$$
$$= O - A$$

thus the subjective angle would remain constant. Such co-variation could be due to a number of causes:

1. Objective angle and angle of anomaly controlled from a common center.
2. Angle of anomaly fluctuates as the primary variable and then the objective angle changes as a result of a movement of the eyes not unlike normal fusion movements.
3. Objective angle fluctuates as the primary variable and then the angle of anomaly changes. Thus correspondence and sensorial adaptation change.
4. The position of the eyes is altered by a "non-registered" innervational pattern: consequently the objective angle changes but the subjective angle does not and therefore the angle of anomaly appears to co-vary with the objective angles. (This is similar to cause one.)

Halldén believed that fusion movements caused the co-variation of the objective angle and the angle of anomaly. He based this conclusion partly on the noted co-variation and partly on changes in the angles which he observed when prisms were placed before the eyes of his subjects.

In many instances, however, the response to the added prism was not complete and in several instances the changes in the angles was not that which would have been expected on the basis of a fusion theory. In addition to those subjects which had responses which were unexpected, there was one subject who had unharmonious anomalous correspondence. This individual reacted to the prisms in the same way as did most of

*Halldén used a technique of measurement which did not depend upon this formula. It is used here for illustrative purposes only.

those with harmonious correspondence—in other words, by a "fusion-like" movement.

It seems to me that this last observation combined with the other exceptions makes the "fusion" theory subject to considerable question. Co-variation can be readily explained by assuming that either the objective angle and the angle of anomaly are controlled from a common center or that some changes in the objective angle are brought about by "non-registered" innervational patterns. The fact that a change in the objective angle did occur in most instances when prisms were added indicates that the reaction to the prisms was not passive and thus the assumption that it was due to a "fusion-like" movement may be true.

This "fusion-like" movement, however, may be a response to restore oculocentric directionalization to that which existed prior to the addition of the prisms rather than to restore singleness of the binocular perception. In many individuals the response was delayed and gradual rather than almost instantaneous as would be expected if this were a normal fusion movement. Alpern and Hofstetter[18] have reported the time course of such "fusion-like" movements for one subject (Alpern himself). This subject had an esotropia of approximately 14 Δ with harmonious anomalous correspondence. A total of 18 Δ base-out was placed before his eyes. After 11 minutes the angle had increased from 14 Δ to 25 Δ. The maximum angle achieved was 32 Δ, a complete response to the prism. This occurred after wearing the prisms for nearly two hours. When the prisms were removed, the change back to the original angle was even more gradual. The subject was not aware of diplopia at any time nor was he aware of any difficulty with visual directionalization in space even though pointing experiments indicated that the "direction of projection was consistently off." Alpern and Hofstetter did not check to see if this pointing error decreased as the squint angle changed.

The mechanism underlying this response might be, as mentioned, the restoration of the previous oculocentric direction difference. Assume that initially the subject had a left esotropia with harmonious anomalous correspondence. The object imaged on the fovea of the right eye would also be imaged on the nasal retina of the deviating eye but since harmony existed this peripheral point would appear to have the same local sign as the fovea of the right eye. Similarly an object imaged on the fovea of the left eye would be imaged upon a nasal area in the right eye. The spatial separation of the two foveal images would be equivalent to the angle of deviation. The amount of rotation needed to fixate any object with either eye in either oculocentric field would also be equivalent to

the angle of deviation. A prism placed before either eye would displace all the objects seen by that eye and would destroy the equivalence of spatial separation and ocular rotation. If the angle of deviation of the eyes were now changed so as essentially to equal the displacement created by the added prism, the usual conditions for this individual would be restored. This restoration would require a disjunctive movement similar to a fusion movement but it might be expected to take place by a sort of trial and error method which would be much slower and lack the precision of a fusion movement of an individual with normal, single binocular vision.

There are some exotropic individuals, as previously noted, who have anomalous correspondence when squinting but who are able to achieve bifoveal fixation. When this occurs correspondence is found to be normal. As a matter of fact, it is found that the angle of anomaly changes exactly in step with the objective angle in most of these cases so that both angles become zero simultaneously. According to Rønne and Rindziunski,[19] Hamburger has reported on other types of squinters with anomalous correspondence who have normal correspondence on achieving bifoveal fixation. It does not seem likely that such large changes in angle observed in these exotropes could be considered "fusional" in nature. Usually these movements are initiated by will although in many instances they can be induced by concave lenses which in turn stimulate accommodative convergence.

Burian and Rønne and Rindziunski have also reported variability in the angle of anomaly and the "depth of the anomalous correspondence." Rønne and Rindziunski[19a] state, "It has been known for years and observed repeatedly that sensorial correspondence in squinters, measured by the angle of anomaly is by no means constant but changes with the observational conditions." They report on a technique which they term the "Prism-rack after-image test" which can be used to demonstrate the nonstability of correspondence in certain individuals.

After-images are developed in each eye and the subject fixates the center of a tangent scale on a wall. Prisms of varying power base-out or base-in are rapidly placed before one eye by running a prism bar up and down before this eye. The angle of anomaly can be determined from the position of the after-images on the tangent scale. Several types of changes have been reported:

1. no change in correspondence
2. change from normal to anomalous correspondence
3. change from anomalous to normal correspondence
4. sometimes the after-images move together or away from each

other smoothly and gradually or in a step or jump-like fashion.

These observations have been confirmed by Hansen and Swanljung[20] and by the writer. I have normal binocular vision with excellent stereopsis and high motor fusion movements. If I place a 30 Δ prism base-out before one eye, while fixating an object on a wall about 1 meter away, and then remove it as soon as fusion is achieved, and repeat this process as rapidly as perception will allow, I notice that the after-images become momentarily displaced after a time. The anomalous correspondence, which exists for a very short time, appears to be harmonious (angle of anomaly equals the power of the prism needed). It almost seems as though the apparent position of the after-image lags behind the movement of my eyes.

Saccadic eye movements have many properties which differentiate them from vergence or following movements. It might well be that one of the factors controlling the "registry" of an eye movement is the speed of the movement. In the experiment described in the preceding paragraph, the constant rapid shifts of the position of an object known to be stationary in space for one eye and not for the other may account for the momentary confusion which results.

Rønne and Rindziunski, like Burian, believe that these changes are due to changes in correspondence and that anomalous correspondence is acquired. They state,[4a] "The phenomenology of anomalous correspondence can best be explained when it is regarded as a sensorial adaptation to the altered position of the eyes, serving as a solution to the otherwise paradoxical perceptions.

"The evolution of anomalous correspondence is perhaps mediated through hypothesized transverse couplings between the two layers of ganglion cells, separated by the white line of Gennari. . . . Anomalous correspondence should consequently be regarded as an anomaly of perception. . . .

"Anomalous correspondence is of the greatest importance for the clinician because it prevents a functional cure of the afflicted patients. The cure of a firmly fixed anomalous correspondence is extremely difficult with the methods available today, therefore, the prophylaxis, which implies early treatment, is our only effective therapy against this condition."

It seems to me that there is a paradox in this idea of sensorial adaptation. Anomalous correspondence is most prevalent in individuals who have squinted for a long time. This would indicate that it takes some time to develop and yet there is considerable amount of evidence that it can be changed instantaneously. Anomalous correspondence is

extremely difficult to change by surgery and orthoptics and yet in many instances it seems to vary greatly without treatment. Adaptation seems to require a stable angle and yet even so-called constant squints do not maintain constant angles for all fixation distances. When there are changes in the angle of anomaly occurring spontaneously, there appears to be a movement of the eyes or a stimulus to ocular movement. Cortical cells near which a fiber from the optic radiations end are anatomically tied to a locus in the retina and not to visual space. Every point in the visual cortex is fixed with respect to the retina but not to space. The spatial relationship is a function of eye position and it changes as the eye moves providing the motor innervational pattern is of the type referred to above as "registered." This ability of visual cortex cells to change "direction" is built in and is normal. These paradoxes disappear if anomalous correspondence is considered an "error" of the motor system rather than the sensory.

On occasion the angle of anomaly is changed by surgery and/or orthoptics. When this change occurs after surgery it may well be that the surgery which altered the objective angle of the squint could also alter the kinaesthetic report of the tension developed in the muscle. Surgery may, by altering mechanical factors, also alter the amount of innervation to achieve a certain movement. Since these factors must be ones which effect the degree to which a movement is "registered," it would be expected that correspondence would appear altered by the surgery in some cases if the motor theory developed here is correct. It is not unlikely that a transition period would exist during which the "old" and "new" report of the innervational pattern exist simultaneously or that the information could not be accurately interpreted and "monocular diplopia" would be reported. The ultimate effect of surgery on anomalous correspondence might be a function of the type of surgery, whether the tendon or the belly of the muscle was altered; whether the nerves, particularly those which carry afferent impulses, were disturbed; or whether the insertion was altered in position.

Walls in his monograph on visual direction briefly considers the possibility that anomalous correspondence may be due to an "altered-innervation-record-employment." He rejects this idea because of the monocular diplopia which sometimes occurs after surgery. One important aspect of this so-called monocular diplopia is frequently overlooked: namely, this is monocular diplopia only during binocular viewing. If the fovea of one eye is represented in the visual cortex in two regions, why does this representation immediately stop when the other eye is occluded? It seems to me that monocular diplopia is more

difficult to explain on the basis of sensory adaptation than it is on the basis of altered innervational patterns which report one eye with respect to the other to be in two positions simultaneously. If the deviation has been corrected, then the same image will be on both foveas. Prior to the surgery, the individual would have moved his eyes in order to place the fovea under the same image as that falling on the fovea of the other eye. After exact correction, this would no longer be necessary—the deviating eye has moved without moving. This could only be true if the eye were in two positions simultaneously.

A theory which is based on an "altered-innervational-record-employment" to account for anomalous correspondence cannot reject entirely what is seen. Certainly there is an interaction between the visual orientation of the individual in space, a function of what is seen, and other reports of the position of the head and body such as those from the labyrinths. Consequently what is seen must be a part of the innervational record and when this is "registered" the registered movement or position must be altered by what is seen. This could account for the reports of Burian and Rønne and Rindziunski that sometimes an individual squinter may have normal correspondence when he perceives positive after-images in the dark when there is an absence of other visual patterns, and anomalous correspondence when he perceives negative after-images in a lighted room in which the visual field is full.

The angle of anomaly is frequently found to be different when a major amblyoscope is used than when after-images are used. This alteration in the angle of anomaly can be ascertained when using only foveal images during the measurement. Usually one finds that harmonious anomalous correspondence by after-image techniques becomes unharmonious on the amblyoscope, especially when esotropia is present. In the case of some exotropes, the correspondence changes from harmonious to paradoxical. As a rule, the angle of squint tends to increase in the esotropic direction when a major amblyoscope is used. If this results in an apparent change in either the objective or subjective angle, the angle of anomaly must change. This change is immediate the first time a subject looks into a major amblyoscope and so it is unlikely that it represents any kind of adaptation. Another factor which must also be considered is that the visual picture in a major amblyoscope is "framed" by the instrument and in spite of the fact that the test objects are optically far away, even the most naive observer knows that they are physically close. This conscious awareness of nearness undoubtedly alters the innervational pattern. This factor by itself might account for any apparent change in correspondence.

In summary, a theory has been presented which attempts to account for anomalous correspondence on the basis of the type of innervational pattern associated with the strabismus. It has been pointed out that certain innervational patterns are "registered" to indicate a change in egocentric direction while others are "non-registered" to indicate no change in egocentric direction of perceived objects. If the innervational pattern is "registered," the altered position of each eye with respect to the other is also "registered" and consequently the "turned eye" reports that what it sees is displaced with respect to the "other eye." This results in anomalous correspondence. If the innervational pattern associated with the squint is "non-registered," the altered position of each eye with respect to the other is not "registered" and consequently the "turned eye" does not report that what it sees is displaced with respect to the "other eye." This results in normal correspondence. In the first instance there may or may not be diplopia and confusion even when suppression is minimal but in the second case there will be diplopia and confusion unless there is suppression. The presence or absence of diplopia and confusion in anomalous correspondence will be a function of the harmony which exists between the actual angle of squint and the registry of the deviation.

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ANNOUNCEMENT

INDIANA UNIVERSITY, DIVISION OF OPTOMETRY

The Indiana University, Division of Optometry, announces receipt of a grant of $2,350 from the National Science Foundation in support of an Undergraduate Research Participation Program in physiological optics. Under the terms of the grant three undergraduate optometry students will be given the opportunity to undertake and participate in research projects under the supervision of members of the faculty of the Division of Optometry who are engaged in physiological optics research. The program will be conducted during the Summer of 1961, June 12 to August 12. Student participants will be selected from nominees and applicants now enrolled in undergraduate courses in the various optometry schools and colleges in the United States. Each of the three students will be given a stipend to cover his expenses during his participation. It is intended that each participant shall have adequate opportunity to explore his aptitudes for subsequent graduate study in physiological optics. The project is under the direction of Professor H. W. Hofstetter, Director of the Division of Optometry.

REFRACTIVE FINDINGS OF 1,000 PATIENTS FROM A MUNICIPAL HOME FOR THE INDIGENT*

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In the fall of 1953 the Pennsylvania State College of Optometry, at the request of the Department of Welfare of the City of Philadelphia, set up a special clinic to examine the residents of Riverview, the city home for indigents. The present report is based on the visual examinations of the first 1,000 such individuals.

In these examinations, the following was noted: (1) age; (2) external examination; (3) ophthalmoscopy; (4) refractive correction; (5) heterophorias; and (6) prism vergences.

ANALYSIS

Age Distribution. Table 1 shows the distribution of ages in ten year periods extending from 30-39 to over 100. The mean age for men and women falls within the 60-69 age period. Of this group, 76.3 per cent are 60 years of age or over while 47.6 per cent are 70 or over.

External and Ophthalmoscopic Examinations. These results revealed 300 or 30 per cent of the patients to have no significant findings while 700 or 70 per cent revealed significant findings. A total of 893 conditions were found for these 700 individuals. Table 2 lists the number of conditions by parts of the eye. By far the most common condi-

TABLE 1.
AGE DISTRIBUTION

Age Group	Number of Patients		
	Male	Female	Total
30-39	6	9	15
40-49	17	31	48
50-59	96	78	174
60-69	169	118	287
70-79	191	126	317
80-89	82	62	144
90-99	7	7	14
Over 100	1	0	1
	569	431	1000

*Read before the annual meeting of the American Academy of Optometry, San Francisco, California, December 13, 1960. For publication in the March, 1961, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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TABLE 2.

NUMBER OF PATHOLOGICAL CONDITIONS BY PARTS OF THE EYE

Lids	20	Vitreous	32
Conjunctiva	14	Optic Nerve	20
Lachrymal System	6	Choroid	29
Cornea	52	Retina	28
Iris	22	Glaucoma	10
Uvea	14	Extra-Ocular Muscles	40
Lens	594	Other	12
Total			893

tion was lenticular changes with 499 patients having incipient lens changes and 58 mature cataract.

Refractive Findings. The refractive data were analyzed from a number of aspects. Monocularly, they were studied on the following bases: (a) type of refractive error; (b) relative incidence of refractive corrections; (c) relative incidence of spherical and cylindrical powers and axis meridians; and (d) presbyopic additions. Binocularly, the data were studied on the bases of (a) type of refractive condition in each eye; (b) equality of refractive correction of the two eyes; and (c) symmetry of the astigmatic corrections. The refractive corrections utilized in this study are either the correction prescribed or the correction which would be prescribed if deemed necessary. All astigmatic corrections are expressed in minus cylinder form.

MONOCULAR BASIS

Type of Refractive Error. Table 3 shows the distribution on the basis of type of refractive error.

Hypermetropia is the most common condition followed by myopia and compound hypermetropic astigmia. The 270 eyes listed under Balance Lens are eyes for which no lens correction could be obtained and include complete or almost complete cataract, extensive corneal opacification, severe fundus pathologies and the presence of an artificial eye.

Hypermetropia is found to be slightly more than twice as prevalent as myopia (56.75 to 23.25 per cent). If we include emmetropia as a spherical condition we note spherical conditions to be almost 2½ to 1 compared to astigmatic conditions (60.55 to 25.95 per cent). Against the rule astigmia is more prevalent than with the rule by 2 to 1 (66.01 to 33.91 per cent). With the rule astigmia (WR) is defined as that astigmia in which the minus cylinder axis lies between the zero degree meridian and the 45 degree meridian and between the 136 degree meridian and the 180 degree meridian, while against the rule astigmia (AR) is that astigmia in which the minus axis lies between the 46 degree meridian and the 135 degree meridian. Against the rule astigmia is

TABLE 3.

RELATIVE INCIDENCE OF VARIOUS TYPES OF REFRACTIVE CONDITIONS

Number of Eyes		Type of Refractive Condition	Spherical	Cylindrical W.R.	Cylindrical A.R.
99	(4.95%)	Emmetropia	99		
774	(38.70%)	Hypermetropia	774		
31	(1.55%)	Simple Hypermetropic Astigmia	31	9	22
330	(16.50%)	Compound Hypermetropic Astigmia	330	99	231
338	(16.90%)	Myopia	338		
36	(1.80%)	Simple Myopic Astigmia		13	23
91	(4.55%)	Compound Myopic Astigmia	91	41	50
31	(1.55%)	Mixed Astigmia	31	14	17
270	(13.50%)	Balance Lens			
2000	(100.00%)		1694	176	343
		Hypermetropia	1135	56.75%	
		Myopia	465	23.25%	
		Other	400	20.00%	
			2000	100.00%	
		Spherical Conditions	1211	60.55%	
		Astigmatic Conditions	519	25.95%	
		Other	270	13.50%	
			2000	100.00%	
		Astigmatic Conditions:			
		With the Rule	176	33.91%	
		Against the Rule	343	66.09%	
			519	100.00%	

also found to be more prevalent than WR when considered from the standpoint of types of astigmia.

Relative Frequency of Refractive Corrections. The most frequent correction found in this study was +0.50 D.S. (100 eyes), followed by plano (99 eyes), +1.50 D.S. (90 eyes) and +1.00 D.S. (73 eyes). The most common myopic correction was —0.50 D.S. with 53 eyes and the most common compound correction was +1.00 D.S. ⌒ —1.50 D.C. with 22 eyes.

The findings between ±0.50 D.S. ⌒ 0.00 D.C. and ±0.50 D.S. ⌒ —0.25 D.C. include 18.1 per cent of all findings, while between ±3.00 D.S. ⌒ 0.00 D.C. and ±3.00 D.S. ⌒ —2.00 D.C. include 73.8 per cent of all corrections.

Relative Incidence of Spherical and Cylindrical Powers and Axis Meridiana. Table 4 shows the distribution of total spherical powers which term is used here to mean all spherical powers prescribed either as spherical corrections alone or as part of a sphero-cylindrical correction. The mean spherical power is found to be +0.95 D.

Table 5 shows the incidence of total cylindrical powers with the mean being —0.75 D.C.

TABLE 4.

RELATIVE DISTRIBUTION OF TOTAL SPHERICAL POWERS

Number Plus Spheres	Dioptric Amount	Number Minus Spheres
64	0.25	39
131	0.50	67
88	0.75	39
123	1.00	60
83	1.25	26
128	1.50	29
75	1.75	15
113	2.00	31
46	2.25	8
74	2.50	13
35	2.75	9
38	3.00	20
12	3.25	6
17	3.50	13
5	3.75	2
26	4.00	6
3	4.25	3
10	4.50	3
6	4.75	1
12	5.00	5
36	5.25 to 8.00	25
26	8.25 to 11.00	5
15	11.25 to 14.00	2
0	14.25 and over	2

TABLE 5.

RELATIVE INCIDENCE OF TOTAL CYLINDRICAL POWERS

Dioptric Amount	Total Cylinders	With the Rule	Against the Rule
0.25	129	40	89
0.50	191	64	127
0.75	73	15	58
1.00	49	15	34
1.25	13	8	5
1.50	22	8	14
1.75	6	4	2
2.00	14	10	4
2.25	3	1	2
2.50	6	6	0
2.75	0	0	0
3.00	5	4	1
4.00	2	0	2
4.50	1	1	0
5.00	5	1	4

Tables 6 and 7 show the distribution of spherical and cylindrical powers in relationship to the basic type of refractive error.

From Table 6 we obtain:

MEAN SPHERICAL POWERS

H	SHA	CHA	M	CMA	MA
+2.00	+0.77	+2.60	—2.07	—1.74	+0.94

TABLE 6.

DISTRIBUTION OF SPHERICAL POWERS BY TYPES OF REFRACTIVE ERRORS

Spherical Dioptric Powers	Hyper-metropia	Compound Hyper-metropic Astigmia	Simple Hyper-metropic Astigmia	Myopia	Compound Myopic Astigmia	Mixed Astigmia
0.25	47		10	21	18	7
0.50	100	13	11	53	14	7
0.75	60	19	4	29	10	5
1.00	73	46	3	50	10	2
1.25	50	30		18	8	3
1.50	90	34	2	27	2	2
1.75	55	20		11	4	
2.00	72	39		26	5	2
2.25	34	10		7	1	2
2.50	56	17	1	10	3	
2.75	20	15		7	2	
3.00	24	13		19	1	1
3.25	2	10		6		
3.50	12	5		13		
3.75	2	3		1	1	
4.00	15	11		6		
4.25	3			2	1	
4.50	8	2		1	2	
4.75	4	2		1		
5.00	9	2	1	4	1	
5.25- 8.00	14	22		20	5	
8.25-11.00	17	9		3	2	
11.25-14.00	7	8		1	1	
14.25 & Over				2		

TABLE 7.

RELATIVE DISTRIBUTION OF CYLINDRICAL POWERS BY TYPES OF REFRACTIVE ERRORS

Cylindrical Power	CHA		SHA		CMA		SMA		MIX A	
	WR	AR	WR	AR	WR	AR	WR	AR	WR	AR
0.25	24	62	2	10	13	7	1	10	0	0
0.50	36	93	4	7	14	22	9	4	2	0
0.75	8	36	0	3	4	9	1	3	3	6
1.00	8	22	0	0	2	7	2	0	2	6
1.25	8	3	0	1	0	0	0	1	0	0
1.50	3	8	2	0	1	5	0	2	1	0
1.75	2	0	0	0	0	1	0	0	2	1
2.00	7	2	0	0	1	1	1	0	1	1
2.25	1	1	0	0	0	0	0	0	1	0
2.50	1	0	1	0	2	0	1	0	1	0
3.00	0	1	0	0	2	0	0	0	2	0
4.00	0	2	0	0	0	0	0	0	0	0
4.50	0	0	0	0	0	0	0	1	0	0
5.00	1	1	1	0	0	0	0	0	0	2

From Table 7 we obtain:

MEAN CYLINDRICAL POWERS

SHA		CHA		SMA		CMA		Mix A	
WR	AR	WR	AR	WR	AR	WR	AR	WR	AR
—0.75	—0.52	—1.30	—0.68	—0.76	—0.72	—0.80	—0.72	—1.52	—1.55

TABLE 8.
DISTRIBUTION OF CYLINDER AXIS MERIDIANS

Axes	Number of Eyes	Axes	Number of Eyes
0-180	144	90	309
10	1	105	6
15	3	110	1
25	1	115	1
30	6	120	4
35	1	125	1
40	1	130	1
45	5	135	10
60	5	145	2
70	1	150	3
75	2	155	3
80	1	160	2
		165	4
		170	1

TABLE 9.
TYPE OF REFRACTIVE CONDITION OF EACH EYE—BINOCULAR BASIS

Total Number Eyes	One Eye Condition	Other Eye Condition EM	H	SHA	CHA	M	SMA	CMA	MA	O
99	EM	23	19	1	3	15	8	2	0	5
774	H		307	2	69	19	2	6	4	39
31	SHA			4	9	1	5	1	4	0
330	CHA				105	7	1	0	5	26
338	M					118	3	24	1	32
36	SMA						5	3	1	3
91	CMA							24	0	7
31	MA								7	2
270	O									78
2000										

TABLE 10.
RELATIVE EQUALITY OF REFRACTIVE CONDITIONS OF THE TWO EYES

Isometropia	639
Anisometropia	135
Antimetropia	36
Undetermined	190
	1000

TABLE 11.
SYMMETRY OF ASTIGMATIC CORRECTIONS

Symmetrical Astigmia	143	41.57%
Asymmetrical Astigmia	201	58.43%
	344	100.00%

The distribution of minus cylinder axis meridians in Table 8 shows a total of 26 meridians. The 90° meridian is the most frequent with 309 eyes or 59.5 per cent. The 0-180 meridian had 144 eyes or 27.7 per cent. Thus we find 87.2 per cent of all axes falling in these two meridians.

BINOCULAR BASIS

Tables 9, 10 and 11 show the results of analysis of the eyes on a binocular basis.

Type of Refractive Error of Each Eye. From Table 9 we note the most frequent combination to be hypermetropia with hypermetropia, followed by myopia with myopia. Further we note that emmetropia is most frequently combined with Em, SHA with CHA, CHA with CHA, SMA with Em, CMA with M and CMA and Mix A with MIX A. In 665 cases (66.5 per cent) we find the basic type error of both eyes to be the same.

In 501 cases we find both eyes spherical, in 174 cases both eyes cylindrical and in 133 cases one eye spherical and one cylindrical.

Equality of the Refractive Correction of the Two Eyes. Inasmuch as a 0.50 diopter of power difference in the vertical meridian cannot be considered of great clinical significance we have classified as isometropic all individuals who show no more than this difference. Table 10 shows the number of persons with isometropia, anisometropia and antimetropia. The undetermined group results from the use of a balance lens because no correction could be determined for an eye. Isometropia is more prevalent by about 5 to 1.

Symmetry of Astigmatic Corrections. In Table 11 we consider the astigmatic corrections from the point of symmetry of the axes. Of 169 persons with binocular astigmia there are 143 symmetrical and 26 asymmetrical. If we consider as asymmetrical astigmia those in which one eye is spherical and the other eye astigmatic we can add an additional

TABLE 12.
DISTRIBUTION OF PRESBYOPIC ADDITIONS

Presbyopic Additions	Number Eyes
0.75	6
1.00	30
1.25	31
1.50	60
1.75	101
2.00	288
2.25	200
2.50	207
2.75	72
3.00	80
3.25	4
3.50	18
3.75	0
4.00	11
4.25	2
4.50	9
4.75	0
5.00	12
6.00	2
7.00	5
	1138

TABLE 13.
DISTRIBUTION OF LATERAL PHORIAS—DISTANCE AND NEAR

Prism	Infinity	Near
7		2
6	1	1
5		
4	4	1
3	2	
2	17	3
1 B.O.	14	
0	34	12
1 B.I.	5	1
2	7	3
3		1
4	3	11
5		5
6		12
7		2
8		6
9		
10	1	8
11		1
12		4
13		
14		3
15		1
16	1	1

TABLE 14.
DISTRIBUTION OF VERTICAL PHORIAS—DISTANCE AND NEAR

Type of Vertical Condition	Prism Diopter Amount	Number of Cases	Infinity	Near
Right Hyperphoria	3		1	
	2		2	1
	1		5	2
Orthophoria	0		70	68
	1		3	1
	2			1
Left Hyperphoria	3		1	1

175 cases of asymmetrical astigmia.

Presbyopic Additions. Table 12 is a listing of the presbyopic additions prescribed for 1,138 of the 2,000 eyes. The mean addition is found to be +2.27 D.

HETEROPHORIAS

Tables 13 and 14 illustrate the lateral and vertical phorias for both distance and near. The mean lateral phorias are 0.12 Δ of esophoria at distance and 5.2 Δ exophoria at near. The mean vertical phorias are 0.07 Δ right hyperphoria at distance and 0.013 Δ left hyperphoria at near.

PRISM VERGENCES

Tables 15 and 16 illustrate the findings for prism divergence and prism convergence and for right supra and infra vergence.

TABLE 15.
DISTRIBUTION OF PRISM DIVERGENCE AND PRISM CONVERGENCE BLUR BREAK AND RECOVERY FINDINGS

Prism Divergence Cases				Prism Convergence Cases		
Blur	Break	Recovery	Prism Diopters	Blur	Break	Recovery
			48		1	
			30	1	2	
			28			1
			24	1	1	
			21	1	1	
			20	4	6	1
1	1		18	2	2	
1	1		17			
	1		16	3	5	
1	1		15	1	1	
	1		14	2	1	1
			13	1	3	1
6	5		12	2	2	2
2	3		11	3	0	
4	4		10	6	3	4
3	3		9	1	1	
9	7	4	8	2	1	5
	1	1	7			1
2	2	2	6			7
		6	5			1
2	4	7	4			3
		1	3			
		6	2			
		1	1			
		3	0			2
			—3			1

TABLE 16.
DISTRIBUTION OF VERTICAL PRISM FINDINGS—BREAK AND RECOVERY

Right Supra Vergence			Right Infra Vergence		
Break	Prism	Recovery	Break	Prism	Recovery
2	6		2	6	
5	5		5	5	
18	4		17	4	
14	3	1	14	3	
	2	14	1	2	14
	1	22		1	22
	0	2		0	2
				—1	1

The mean blur, break and recovery for prism divergence are 9.78 Δ/10.29 Δ/4.03 Δ and for prism convergence 14.56 Δ/17.6 Δ/8.06 Δ. The mean findings for right supra and infra vergence break and recovery are 3.87 Δ/1.35 Δ and 3.92 Δ/1.25 Δ.

DISPOSITION OF CASES

Table 17 illustrates the disposition of the 1,000 cases. 56.4 per cent of the patients were given spectacles and 43.6 per cent were not. Bifocals were used most frequently (48.2 per cent of the spectacles prescribed). The most frequent reason for not prescribing spectacles was due to the mental condition of the patient.

TABLE 17.
DISPOSITION OF CASES

Rx Prescribed		564
Distance	190	
Near	98	
Bifocal	272	
Two Pair	4	
No Rx Prescribed		436
No Change	125	
Mental and Senile	231	
No Help	80	
		1000

DISCUSSION

In 1954 a study was made by this author of 1,000 consecutive patients seen at the clinics of the Pennsylvania State College of Optometry.[1] In analyzing the results of that study with other reported studies the results were found to be quite comparable. Therefore, the results of this present study will be compared with our 1954 study, as well as with certain findings reported by Haines[2] in 1941.

AGE DISTRIBUTION

This present study covers a more restricted age group than the previous one with our mean age being in the 60-69 age group compared to 39.7 years in the previous study. We, of course, would expect those persons in a municipal home for indigents to be from the ranks of our senior citizens.

EXTERNAL AND OPHTHALMOSCOPIC EXAMINATIONS

The incidence of some significant finding in the external and ophthalmoscopic examinations is considerably higher in this study compared to other studies.

Riverview	70.0%
Clinic	28.7%
Borisch[3]	8.4%
Juveniles[4]	5.4%

In each of the first three studies disturbances of the crystalline lens was the most prevalent condition.

REFRACTIVE FINDINGS

The most significant differences in the categories of refractive findings are in the percentages of patients with spherical refraction as compared to cylindrical and in the percentage of balance lenses. This present study shows a much greater percentage of spherical refractions as compared to cylindrical (2 to 1). There are several possible explanations for this. First, one must consider the type of person to be found in such an institution as this. I have not made a sociological study as to the background of these people. However, we do have some facts and

personal observations upon which to base reasonable conclusions. Of the 1,000 persons, 139 were found to be illiterate. 97 were persons sent from a municipal mental institution because of overcrowding. They were obviously not severe mental patients but still were mental patients. 40 persons were either receiving or were candidates for blind pensions. Many of the individuals, because of their advanced age, showed characteristics of senility. Second, we must consider the high incidence of pathology and particularly lenticular disturbances. All this leads to possible questionable static or subjective refractions, at least from the standpoint of the low astigmats. Quite possibly some of the spherical refractions were actually low astigmats but the ability to detect or the feasibility of prescribing led to a seemingly high percentage of spherical lenses. The higher percentage of Balance Lens (6-1) is readily accounted for by the high percentage of pathologies.

One other source of variation is in the percentages of with-the-rule and against-the-rule astigmia. In the previous study W.R. was more prevalent by about 3-2 while this present study shows A.R. more prevalent by 2-1. Most studies indicate an increase in A.R. astigmia with age so these results are not unexpected.

The phoria and prism findings of this study when compared to those listed by Haines are not too inconsistent. The character of the patients made many of these findings impossible or of questionable validity and the relative fewness of these findings can well account for the variations where they exist.

SUMMARY

1—1,000 persons in a municipal home for the indigent were examined and a series of refractive findings noted.

2—Ages were from 30 to over 100 with a mean of 60-69 years.

3—Refractive data shows

a—Monocular

1—57% hypermetropia, 23% myopia.

2—60% spherical, 26% astigmatic.

3—34% W.R., 66% A.R.

4—Most frequent individual correction +0.50 D.S.

5—Mean correction was +0.95 D.S. ⊃ —0.75 D.C.

6—Most frequent axis meridian 90 degrees.

7—Mean presbyopic addition +2.25 D.S.

b—Binocular

1—A relative similarity in the type of refractive condition in each eye.

2—Anisometropia of greater than 0.50 D. in vertical me-

ridian occurs in approximately 1 of 4 cases.

3—Symmetrical astigmia occurs in only about 40 per cent of cases.

c—Phorias and prism vergences findings in normal ranges.

4—Pathology.

Lenticular disturbances most common condition.

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ANNOUNCEMENT

FIFTIETH ANNIVERSARY CELEBRATION SCHOOL OF OPTOMETRY—UNIVERSITY OF MONTREAL

Dr. Charlemagne Bourcier, Montreal, announces that the School of Optometry, University of Montreal, is celebrating on the 9th and 10th of April, 1961, the fiftieth anniversary of its foundation. A full two days' Congress will be held on this occasion.

Speakers at that event will include Dr. Louis Jacque, Dean J.-Armand Messier, Drs. Henri Coté, L.-Philippe Raymond, Jean Bergevin and others. We expect most of the optometrists of the Province of Quebec to be present and we cordially invite the optometrists of the other Provinces of Canada and also from the United States who wish to join us for this celebration.

Registration will be held at 9 o'clock a.m. at the University of Montreal and the opening of the Congress is scheduled for 10 o'clock. Fees are $15.00 per member optometrist or $25.00 per couple, including all social events. Check may be sent to Edgar Lussier, secretary, School of Optometry, University of Montreal, Montreal, P.Q., Canada. A hearty welcome to all!

LAWS OF LEARNING, VISUAL PERCEPTION AND THE READING PROCESS*

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When I was asked to deliver an address with the above title, I immediately ran into a question which might not occur to one without knowledge in the field of psychology. That question is,"'Whose laws of learning?" I suppose it is to the very great influence of E. L. Thorndike[24, 25] that we owe the widely-held notion that there just "are" laws of learning. The so-called "Laws" of Effect, Readiness, Exercise, Frequency, Recency, Vividness, and the rest have acquired a secure place in the thinking of many non-psychologists. And yet, in the modern sense, these are not laws at all.[5]

Psychology is unique among the sciences, in that in its popular conception no other science is still so strongly steeped in philosophy, mysticism, folklore and superstition. In his eagerness to know, Man has shown greater reserve about himself than he has about the rest of the Universe. Whereas it has seemed reasonable and "practical" and moreover sensibly "true" that the presumably existent external world can be described in lawful terms, Man himself, with his theologically imputed soul and his personally experienced self-awareness and his communicable similarities, has seemed a being apart, a thing of different kind. Through the exercise of his amazing rational powers, he has invented many schemes for enabling himself to feel that he understands and can explain, or at least that he knows where sheer "faith" must carry the load of giving him serenity. In these schemes and these faiths, there occur many declarative sentences and many questions only intuitively answerable. Through numberless repetitions these declarative sentences and these intuitive answers have acquired the aura of "Truth" or "Law," especially in view of the lack of experience which would refute them, and in view of an observed tendency on the part of human beings to ignore or even to resist actively experiences which might disturb the highly valued serenity so precariously achieved.

Let us look at the original three so-called "Laws of Association," propounded by Aristotle,[4] and upon which have been based many

*Read before the Third Annual Visual Training Seminar, Bowling Green State University, September 18, 1960. For publication in the March, 1961, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
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changes in the development of modern learning theory. These three laws were those of Similarity, Contrast and Contiguity. Aristotle said, in effect, that it is as if the mind makes connections among things because they are similar, or because they are sharply contrasting, or because they occur together in space and time, and that it is these characteristics which affect our mental processes. He observed persons recalling things, it is true, and he thought that he could describe and explain what they did in terms of these "Laws." But, he did not make *controlled* observations in which he could isolate these characteristics and study them separately, nor did he have any quantitative measures of the things he was supposed to be observing. He simply observed acutely and described according to principles already proposed. This was the rational approach, as contrasted with the empirical approach, and it was to be the prevailing method of "study" for a long time. Whereas the notions of measurement and quantification became important in other fields of endeavor rather early, it was not until the middle of the last century that anyone thought they could be used in any way in the study of mental processes. Even then, the psychophysical methods first devised by Gustav Fechner were an attempt to state a relationship between the external world and the human soul, and not the attempt to understand behavior that we make today.

Furthermore, we must understand that mathematical and philosophical developments were necessary. It is an agonizing delay from Gauss and Quetelet to Fisher and Thurstone. Because the observational situations in psychology are so much more complex than those of the chemist or the physicist, control or even identification of all the variables which determine behavior is very difficult, if not at the moment impossible. Only the development of statistical methods based upon the assumed random variation of very large numbers of independent factors could make it possible to achieve the quantification sorely needed (and now, further developments have become necessary in methods based upon variations in quantity and relational changes among very large numbers of *non*-independent variables.) In philosophy, we had to work through from Aristotle and Descartes to Bridgman and the Vienna Circle, from mysticism and rationalism to logical positivism and operationism, in order to set the model for current theorizing.[5, 20, 23]

Now, in modern theory, notice is taken of the semantic problems in thinking and communication. It is recognized, for example, that statements may exist with differing levels of significance. Particularly, a statement may exist as an expression of a personal observation, experience, or thought without having any systematic or theoretical signifi-

cance at all. That is, it may at one and the same time be a meaningful statement and a meaningless statement.

Let us consider an example, for which I am indebted to one of my former professors, the renowned theoretician and philosopher Gustav Bergmann, and called by his students the "Bergmann Coefficient."

$$B = \text{number hairs on head} \times \frac{\text{pulse rate}}{\text{blood volume}}$$

With care in measurement and computation, B-coefficients of satisfactory reliability could be discovered for any individual or for groups of individuals, as desired. However, there is no known practical or theoretical use for such a coefficient! Thus, where a concept or a statement may have meaning in the sense of repeatibility and verifiability, as in the case of the B-coefficient, it may have no meaning whatsoever in terms of being assimilable into a theoretical system, where such concepts and statements must exhibit stateable relationships with other concepts and statements, and in modern thinking must be reducible to operational and quantitative terms.

It is in the first of these two senses that we had "Laws" of learning in Thorndike'e day, and it is in this sense that most of us still "know" these "laws." It is the latter position that we seek as an ideal for explanation, prediction and control. Certainly, it is one thing to observe that a moving stimulus in the visual field regularly precedes a shift in fixation, and make a statement to that effect, and quite another thing to explain how this comes about, to predict variations in it, and to control it.

So it is that we have in psychology today a much more sophisticated theory-making, and sets of "laws" which differ much from the old laws. Because we are in the early stages of our theory-making, we have more than one approach, using more than one set of concepts, but all seeking the same goal. For that reason, it is necessary for the serious student of psychology, education, and related disciplines to be knowledgeable about these theories. To name a few, we have the S-R behavioristic theory of Clark Hull, the purposive behaviorism of E. C. Tolman, the operant-respondent conditioning approach of B. F. Skinner, some attempts to apply such field theories as that of Kurt Lewin, and others even newer and more sophisticated.[15]

Now, the existence of these several theories does not mean that psychologists do not know very much. The truth is, that we know almost *too* much—too much, that is, to have accomplished the tremendously complicated and challenging task of establishing a single, ade-

quate theory. After all, if we go far enough into physics, astronomy, geology, etc., we find a similar situation. Man has a long way to go in understanding himself and the Universe, despite some signal successes already achieved. But, does the existence of disagreements at the most abstract of theoretical levels indicate serious disagreement at the more basic levels? Hilgard says not. There may be certain disagreements in *explanation* of what happens, but there is very little disagreement as to just what *does* happen.

To illustrate what Hilgard calls "some agreement on practical matters," let me mention his admittedly incomplete list of statements, and let me emphasize again that these are matters in which the practical occurs, whatever the theoretical attempt to explain. I quote here from Hilgard[13] with comments of my own in parentheses.

1. In deciding who should learn what, the capacities of the learner are very important. Brighter people can learn things less bright ones cannot learn: in general older children can learn more readily than younger ones; the decline of ability with age, in the adult years, depends upon what it is that is being learned. (It should be noted that "brighter" is usually made known by "learning better," and that "decline of ability with age" rests upon observed changes, and perhaps not upon necessary ones.)

2. A motivated learner acquires what he learns more readily than one who is not motivated. The relevant motives include both general and specific ones, for example, desire to learn, need for achievement (general), desire for a certain reward or to avoid a threatened punishment (specific). (Again, we might suggest that decline of "ability" with age may come from changes in motivation. Highly motivated oldsters may show no decline at all in many important intellectual functions.)

3. Motivation that is too intense (especially pain, fear, anxiety) may be accompanied by distracting emotional states, so that excessive motivation may be less effective than moderate motivation for learning some kinds of tasks, especially those involving difficult discriminations. (We say of a person that "he is trying too hard." All experienced teachers, coaches, etc., know to watch for this condition.)

4. Learning under the control of reward is usually preferable to learning under the control of punishment. Correspondingly, learning motivated by success is preferable to learning motivated by failure. Even though the theoretical issue is still unresolved, the practical outcome must take into account the social by-products, which tend to be more favorable under reward than under punishment. (This is very complex: in our own laboratories we have found that the relationship between punishment and reward is very important. We can make a response very resistant to extinction if punishment precedes reward and is continued during extinction, and with college students we can make the receipt of punishment serve as the reward for learning a new series of responses.)[3, 10, 11]

5. Learning under intrinsic motivation is preferable to learning under extrinsic motivation. (A subject interested in the task itself will learn it better or faster than one who must be engaged by means of rewards not directly related to the task itself. A pupil who enjoys reading for its own sake, and who discovers for himself the self-enrichment which follows will read more, faster, and retain better than a pupil who wants a good grade, or who must satisfy his parents or the teacher, or who does not want to look foolish to his classmates.)

6. Tolerance for failure is best taught through providing a backlog of success that compensates for experienced failure. (Actually, pupils need to learn how to fail successfully. Our culture stresses the winner too much, and largely ignores him who runs well but does not win. The resourceful pupil is the one who has had things go wrong, who has had to try again, to find out what was wrong, to see if another kind of approach will work, to look for previously unrecognized relationships, and so forth. Of course, success is desirable, even if he needs some help to get it, but the failure barrier may be used to enhance the flexibility of the learner.)

7. Individuals need practice in setting realistic goals for themselves, goals neither so low as to elicit little effort nor so high as to foreordain to failure. Realistic goal-setting leads to more satisfactory improvement than unrealistic goal-setting. (The need for evaluation and measurement programs in the schools seems obvious here. A realistic goal is one which is set with full knowledge of what one can expect of himself, plus a little extra to which he aspires. Anything else, whether it comes from the pupil himself, his teachers, his peers, or his parents, is a kind of un-sanity.)

8. The personal history of the individual, for example, his reaction to authority, may hamper or enhance his ability to learn from a given teacher. (There is an obvious stress here on learned habits and habitual emotional responses, with no implication that the pupil is necessarily *aware* of the existence of such habitual response structures.)

9. Active participation by a learner is preferable to passive reception when learning, for example from a lecture or a motion picture. (The literature does indeed support the contention that active learning is superior to passive; but we must note that the pupil can learn to be active in getting information from lectures and motion pictures. Good note-taking, for example, need not be mere copying, but can represent the results of an active synthesis of what one hears or sees.)

10. Meaningful materials and meaningful tasks are learned more readily than nonsense material and more readily than tasks not understood by the learner. (We must note that sense and nonsense are not necessarily attributes of materials themselves. The learning history and the motivation of the learner come into it. The boy who dislikes reading in school about the dog getting the ball and Mary visiting Ruth's house may read avidly to get information bearing upon his hobby of model airplane building.)

11. There is no substitute for repetitive practice in the overlearning of skills (for instance, the performance of a concert pianist) or in the memorization of unrelated facts that have to be automatized. (It has long since been shown, however, that the real function of repetition is to allow the real determiners of learning to function. Even Thorndike, who did have a Law of Frequency, finally admitted that it alone was not a sufficient condition.)

12. Information about the nature of a good performance, knowledge of his own mistakes, and knowledge of successful results, aid learning. (I think the first two of these may be lacking in reading training. The pupil knows when he has read acceptably, but even many teachers of reading do not know the nature of a good performance, and do not diagnose pupil mistakes with reference to these characteristics. The reason for this probably is that the performance of really good readers in many respects does not conform to what we try to teach.)

13. Transfer to new tasks will be better if, in learning, the learner can discover relationships for himself, and if he has experience during learning of applying the principles within a variety of tasks. (It is almost a truism, since the days of Herbart, that transfer should not be left to chance. The school and the home must cooperate in giving pupils encouragement in achieving transfer of the skills being taught in school. Lack of such cooperation is one thing making our teaching job so difficult.)

14. Spaced or distributed recalls are advantageous in fixing material that is to be long retained. (This does not refer to massing or distribution in learning. Some materials and some skills are better learned by massing, some by distributing. But, once the criterion level of performance has been reached, maintenance of the learning depends upon its occasional use: otherwise, the elements involved in the specific performance become involved in other response patterns to the extent that singling out the specific performance becomes difficult.)

These general statements have been combined into seven "Conditions" for effective learning by Frandsen,[6] and have been applied to the teaching of school disciplines, including reading.

Now, the suggested title of my presentation indicates that I am to say something about the relationship between visual perception and the learning process. The crux of the matter here seems to be the problem of the extent to which each depends upon the other. Since perception is

viewed by most psychologists as a process or a set of intervening variables of one kind or another occupying a temporal position between sensory activity, or stimulation, on the one hand, and other events such as the occurrence of awareness and the initiation of other response processes on the other, the question arises as to how much of visual perceptual processes are learned and how much they lay a basis for further learning without themselves having to be learned. The role played in one's theory of learning by perceptual constructs will depend upon whether one's emphasis is upon the learning of perceptual processes or upon their innate or *a priori* or "natural" occurrence as basic to learning, or perhaps upon one's particular synthesis of these views.

It will be impossible, in the time at our disposal, to review all the voluminous literature on vision and visual perception, and so let me take up some illustrative experimentation and see if we can agree upon an interpretation.

First, and I think very important for the study of reading, there still regrettably exists a central-peripheral controversy which undoubtedly had its roots in Watson's attempt to rid himself of mentalistic concepts by emphasizing observable peripheral processes. Watson went so far as to reduce such activities as those of thinking and problem-solving to acts carried on in the musculature. Early investigators were concerned with identifying and describing oculomotor behavior during reading. Dodge's eye-movement camera made it possible to discover that eye movements were variable under a variety of conditions, and that the good reader was superior to the poor reader in oculomotor habits. The peripheralistic view became strong, and still influences many laboratories and reading clinics. Dearborn has said that oculomotor habits were causally related to reading ability, and Cole that the good reader is good *because* he shows efficient eye-movement patterns, and a host of others have made similar statements. However, Tiffin said in 1937[25] that the quality of reading is determined more by central than by peripheral factors, my own research has indicated the same thing,[7] and Marvel[18] has again put forth the view that central factors such as set, motivation, comprehension and the like are determiners of the visual-perceptual process of reading, and that most training devices are simply not necessary. When one can produce impressive gains by means which do not train peripheral factors, such as the tachistoscope (e.g., it is contraindicated by various lines of research that visual acuity *per se* improves with practice) or by sitting a highly motivated subject down with an alarm clock and a copy of the school edition of *Reader's Digest* and the firm belief that he can improve his reading, one is strongly drawn toward the central side of this controversy.

A singularly stimulating book for one interested in these problems has been written by Hebb.[13] If one grants Hebb his distinction between primitive figure-ground distinction and identification, then either field theories of learning or stimulus-response theories can handle the experimental findings acceptably. However, beyond the primitive figure-ground distinction, learning appears to play a predominant role, and since peripheral mechanisms are not abnormal in the subjects used, central factors appear to be relatively the more important. I refer to the work of Hebb himself, of Riesen.[21] Senden.[22] and of course several others. Senden reports the findings of a number of studies on human subjects who have been operated upon for congenital cataract. Figure-ground separation appears to be good, but identification is not. The perception of geometric figures is very poor: even the brightest and most strongly motivated subjects have to count corners carefully to tell a triangle from a square, or even a triangle or square from a circle. The subject often can find differences between two such figures shown together, but he does not remember the differences, and it takes weeks to learn names for such figures, even though the subject may have excellent tactual recognition. Moreover, there is failure to generalize normally. If the subject learns to name a white square, he cannot name a yellow one: if he learns to recognize a cube, he fails if the background is changed: if he learns to recognize a ring or circle, he cannot recognize a slightly different one: he does not recognize objects visually, but must slowly learn to coordinate his new visual sensations with previously learned tactual ones. In one patient, an egg, potato, and sugar cube could be named promptly after long training, but then were not recognized when placed in colored light. Colors themselves are quickly learned, but form recognition may be delayed for many months. Apparently structural defects in the sensory apparatus itself are not a cause, inasmuch as these patients generalize in a normal way, when learning has proceeded over a long enough period of time.

Hebb, Riesen and others have studied the "same" thing in animals, for example, in animals reared in darkness. Normally, a chimpanzee which is 15-18 months of age readily learns relatively complicated discriminatory and choice responses to visual stimuli. If punishment is involved, such as electric shock, he avoids the punishing object after two or three contacts with it. A chimpanzee reared in darkness to the same age, however, does not discriminate visually. A visual discrimination which takes the normally reared chimpanzee, say, 20 trials to learn, may take the darkness-reared chimpanzee 200 trials, or even 2,000. He may be shocked repeatedly, for many days, before he learns to avoid

punishing objects. The darkness-reared chimpanzee may make anticipatory eating movements at the smell of food, but responds not at all to the food-cup in which it has been given during his lifetime: i.e., he does not recognize it visually, and can not find it when it is offered to him, until it touches him. Normally, chimpanzees show good recognition of the experimenters who work with them every day, and respond differently to them, showing preferences and aversions. This is totally lacking in dark-reared animals, and may take weeks or even months to appear after the animal is brought into the light. Riesen reports that when dark-reared animals are brought into the light, they show good pupillary reflexes, show startle reactions to sudden increases in intensity of illumination, and normal nystagmus. To check the possibility that some functional or organic damage occurs from deprivation of light stimulation, other chimpanzees were reared with their heads enclosed in plastic globes, which permitted light stimulation but kept the light diffused so that there was no form-discrimination learning possible. The results were as described above.

Another line of research which I think has similar implications has to do with what has come to be called "figural after-effect." These are produced by having subjects fixate a point in a visual stimulus field in which there is also a figure, such as a line or a circle or square, or a pattern of such elements. After a period of fixation, a second visual stimulus field is substituted, also with a fixation point and geometrical figures. The effect is present if the subject perceives the second set of figures to be distorted from their objective characteristics. For example, we might have a curved line with a fixation point at its center, which is fixated by the subject for a set period of time, say, three minutes. This is called the inspection-figure. Then there occurs a quick substitution of a card bearing a straight line with a fixation point at its center, which line occupies the same position in the visual field as was occupied by the curved line. This is the test-figure. The effect is present if the subject perceives the objectively straight line as being curved or bent in a direction opposite to the curvature of the line on the inspection figure. Or, we might have a stimulus card with a fixation point, to one side of which there is a square or a circle. After this inspection-figure has been presented for a time, there is substituted a test-figure in which there are two objectively equal, smaller squares—one on either side of the fixation point. The effect is present if the subject reports the square of the test-figure which is on the same side as the circle of the inspection-figure to be smaller than the other, or more pale, or if it seems to be farther away than the other.

Figural after-effects are not to be confused with after-images. After-images represent ongoing activity in the subject after a source of stimulation has been removed. Figural after-effects represent the influence on a present percept of a previous percept. A number of studies have been done to discover the duration of such effects, their rise and fall, etc., but I have found only one bearing upon the reading process as such. Since reading involves the rapid succession of geometrical figures in visual stimulation, it seems reasonable to suppose that there might be a relationship between reading ability and the occurrence or persistence of figural after-effects. Bales and Follansbee,[2] in fact, report that the reading of news clippings in the interval between presentation of figures is associated with a greater incidence of figural after-effect than is the fixation of a black dot on a white background. In a study done in our own laboratory,[9] a series of figures taken from Gibson[12] and from Kohler and Wallach[16] were presented to 24 Introductory Psychology students, individually. The figures were drawn in India ink on white cards 8 x 5⅝ inches in size, and shown to the subjects at a distance of six feet. The inspection-figures were shown for three minutes, and the test figures for two seconds, with one second between. One such pair was shown to each subject at each session on successive days to avoid interaction among pairs of figures. Product-moment correlation coefficients were then computed between scores on the after-effect series and the total and subtest standard scores on the Iowa Silent Reading Test, which had been previously administered. All the obtained coefficients were positive but one (Directed Reading), all were near zero-order for this number of subjects except two (Comprehension and Selection of Key Words), and only one was significant at the 5 per cent level (Selection of Key Words). Comprehension missed the 5 per cent level by a very small margin. I think this needs to be followed up, with several factors being the object of research. For example, Freeburne and Hamilton[8] have shown that the relative brightness of figure and ground produces an odd interaction, in which there is successively *less* appearance of after-effect in successive sessions with a high brightness differential, and successively *more* with successive sessions at a low brightness differential. It may be that the product-moment correlation cofficient is not the one to use—the relationship may be curvilinear instead of rectilinear. It may be that training in introspection, in what to look for in figural after-effects, would alter these findings, although one has to control for the effects of suggestion. There could very well be age differences, and there could have been selective factors operating in the subjects used. Similar comments could be made concerning reading and what the

Gestaltists call "closure" although I will not go into that literature now. I hope to have graduate students doing some research of this kind. It seems obvious that we are here concerned with central processes of some kind, and the performance of exceedingly good readers, who leap from one to another of only five or six fixations on an entire page with excellent comprehension, indicates that somehow there is vastly superior recognition and conceptualization on the basis of fleeting and very fragmentary cues, and that this must be a central process of some kind.

One final line of research, and I will have used up all of my time, with apologies for my many omissions. You know of the really vast literature on training in perceptual span and in perceptual speed and its effect on reading performance. You do get improvements in reading, but such training is usually "along the line": that is, it conforms to our long-established ways of printing reading materials. The considerations already given suggest that the really good reader makes as much use of his vertical perceptual span as he does of his horizontal. Witty and Bricker[27] noted faster reading and better comprehension with materials making use of the vertical visual span (thought-unit phrases) and Prentice-Hall published a book by Hepner[14] in what is called "square span," after an article by Andrews.[1] In 1950 North and Jenkins published a study comparing standard, phrase unit, and square span materials.[19] They used a large number of subjects (180) but gave only a few minutes practice (4 and 8). They found the phrase unit materials better for both speed and comprehension than standard or square span materials. There was strong likelihood that the very small amount of practice given was not enough to give square span a chance, however, and their square span took in only two lines. We sought to remedy these defects.[17]

We used forty subjects, randomly assigned to four groups of ten each: (1) standard typography practice, (2) phrase-unit typography, (3) square-span typography practice, and (4) no-practice control. All subjects were given the Triggs Diagnostic Reading tests (Form A) for Comprehension and Rate. The same test was given before and after training, with the control group allowing an evaluation of the effect of taking the test twice.

After the initial test, subjects were given ten days of practice with their respective materials. There was a ten-minute session on each of ten successive days, using reading selections of approximately 3,000 words, specially set into typography appropriate for each group. A comprehension test followed each day's reading. Using Festinger's "d," we found:

(1) no differences among the practiced groups significant at an acceptable level;
(2) phrase-unit group increased over the control group in rate at the 0.01 and 0.05 levels, respectively for the two parts of the test, but not in comprehension;
(3) square span and standard typography groups showed no increase over the control group at an acceptable level of significance.

A number of problems turned up in this study also. For example, on final testing, several subjects achieved maximum scores on the Triggs Test. This may have covered up important information on gains in some groups. Again, the spacing and length of practice sessions might be profitably investigated. Further, the cost of materials led us to use the Triggs Test "as is," instead of setting it up in phrase-unit and square-span styles. It probably would be better to use a counterbalanced factorial design in which testing is done with materials set up as practiced. We used three-line square span, whereas Andrews and North and Jenkins used two-lines; there is the question of the optimal size of the square-span block.

These investigations, and many not even mentioned in passing, have produced results which are not theoretically critical. That is, Hebb might explain in terms of growth in number of boutons in Brodman's Area 17, Kohler might explain in terms of assumed electrochemical processes in the brain, or Hull might talk in terms of neural interaction and the little perceptual response-stimulus mechanism. As in the case of Hilgard's "Fourteen Points" or Frandsen's "Seven Conditions" mentioned earlier in this paper, the empirical findings and conclusions have generality and immediate practicality, and they may be put to use and statements may be made about them which do not have theoretical significance. The findings do exist, however, and new questions for research are suggested, and the theorist of whatever stamp must eventually encompass the findings within his theoretical framework. Unfortunately for an entirely successful theory of learning and its application to problems of visual perception and reading training, too many studies have flaws, too many findings are in disagreement or inconclusive. Despite the problems, however, the research must go on, and so must the theorizing, because they mutually complement one another, and one without the other is unthinkable in modern science.

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AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY
Established 1924

Vol. 38 March, 1961 No. 3

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Annual Subscription, United States and Canada, $8.00 in Advance; Foreign, $9.00; Single Copies 80c

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Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

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SOME WORTHWHILE OPTOMETRIC, OPTICAL AND OPHTHALMOLOGICAL BOOKS*

Starting a letter with an apology or beginning an article with a long explanation probably have something important in common—we may discourage our readers from getting beyond the first paragraph. But once in awhile, an article just *has* to be written (this one has been brewing for some time), and we're afraid it will make no sense at all without an initial explanation, so "here goes."

It seems that a very long time ago the American Optical Company had a publication called WELLSWORTH. There are no files in our library, and we would most certainly never have heard of this publication had

*A Report by Mrs. Harriette M. Cluxton, B.A., B.S., (Lib.). Former Librarian, Illinois College of Optometry. Fellow, American Academy of Optometry. Submitted on January 16, 1961, for publication in the March, 1961, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

we not been offered an old magazine, dated 1917, by Dr. E. H. Robison, Jr., who had found it in the library of his late father in Frankfort, Indiana.

Upon examination, this proved not to be a single copy of the OPTICAL JOURNAL AND REVIEW OF OPTOMETRY for May 24, 1917, as the cover would have us believe, but a series of significant articles over about a four-year period, pasted together, inside the described cover. And along in the middle, WELLSWORTH, containing the article bearing the title we have altered and preempted, by the great Charles Sheard, Ph.D. (Since then he has accumulated a veritable alphabet of degrees.)

It seems that Dr. Sheard and the American Optical Company (for whom he was then working) had received numerous inquiries for lists of books on refraction, ocular muscles, diseases of the eye, etc. You must remember that the authors of these requests had little of the professional optometric education that our readers have today . . . (by checking references, we feel certain this article was written in late 1918 or early 1919) . . . and he vigorously applauds their efforts to improve themselves. He says he is delighted to comply, but adds, "My only fear, in all my correspondence and in this article, too, has been, and still is, that so very few minds are so constituted as to lend themselves to the perusal of any list of books," and he points out the danger of making suggestions as "a book much admired by one may be of little service to another."

Nevertheless, for the practitioners of another day, Dr. Sheard proceeds to suggest a personal professional library. Forty years later, with perhaps 1/10,000's of the great man's knowledge, but with nearly six years of work in what we fondly hope is an outstanding optometric library, where all these books are old friends, we're going to try to write the modern parallel. Will you forgive our temerity as well as our choices—and read on?*

Under "Ordinary Reference Books," Dr. Sheard names a Webster or Century unabridged dictionary; a medical dictionary, such as Gould; a standard anatomy, such as Gray's; a standard physiology, such as Howell's; and a satisfactory textbook in algebra, geometry, and trigonometry. Allowing for the differences in edition (Gray's is now in the 27th), we have no quarrel with this list at all, although the mathematics books may not be quite so vital now. The descendant of Howell's, Ruch and Fulton's *Medical Physiology and Biophysics* might be replaced by the more general Houssay's *Human Physiology* (2nd ed.).

*All quotations are from Dr. Sheard's article.

Among the basic books we would now wish to add a text in *Ocular Anatomy*, perhaps Spooner's, bearing that title (Hatton Press), as Wolfe's *Anatomy of the Eye and Orbit* is currently out of print. *Principles of Perception* by Bartley (Harper) is useful as a visual psychology text.

In the section "On Lenses, Mirrors, and Prisms," Dr. Sheard feels that Laurance's *General and Practical Optics* is the best book (then) available, but that Southall's "new" book, *Mirrors, Prisms, and Lenses*, "will fill a very valuable place in optical literature." (Macmillan.) The third edition of Southall is on the "Reserve" shelf, while Laurance has retreated to the open shelves with Edser's *Light For Students* and Percival's *Optics* and Prentice's *Ophthalmic Lenses*. The latest edition of Fincham's *Optics* (6th, Chilton) or perhaps *Fundamentals of Optics* by Jenkins and White (3rd, McGraw) might be today's alternate suggestions.

All of the books named in "On Refraction" are probably available only in college libraries or perhaps second-hand bookstores now. He especially recommends Alger's *Refraction and Motility of the Eye* and two of Thorington's *Refraction and How to Refract* and *Methods of Refraction*. Today there are several texts from which a selection can be made according to one's "lights," including Borish's *Clinical Refraction* (2nd, Professional Press); Manas' *Visual Analysis Handbook II* (Professional Press); and the brand new exhaustive survey of all aspects of refraction, Giles' *Practice of Refraction* (Chilton). For a dispensing text, Kozol's *Ophthalmic Fitting and Adjusting* (Chilton), or perhaps Stimson's *Ophthalmic Dispensing* (Educational Foundation in Ophthalmic Optics) could replace the old Pixley's *Optical Primer*. (Some of the pliers look familiar, but oh, those frames!)

Articles on "Skiametry or Retinoscopy" occasionally appear in professional periodicals. We doubt if the individual optometrist would now need a whole book on this subject for his personal library.

Under "Ocular Muscles" Dr. Sheard lists books by Reber and Maddox bearing that title, and calls Savage's *Ophthalmic Myology* "one of the most stimulating and think-making books I have ever read." Although not exactly comparable, Smith's *Clinical Orthoptic Procedure* (2nd, Mosby), in conjunction with a good physiology-anatomy text, may give the modern doctor all he needs on this subject. Scobee's *Oculorotary Muscles* is out of print.

The classic works on "Physiological Optics" are of course still those of von Helmholtz and Tscherning. A long section on this sub-

ject by the great scientist himself [Sheard] had just appeared in the monumental *American Encyclopedia of Ophthalmology*. Dr. Sheard impersonally lists this, as well as his work on other topics we have mentioned. As you know, the best of his writings reappeared in the *Sheard Volume* in 1957 (Chilton). An adequate text on this subject for college use is high on the priority list of desired books, as reported recently by the Association of Schools and Colleges of Optometry. Dr. Glenn Fry is working on an advanced book. The book many of you prize, Zoethout's *Physiological Optics*, is out of print and virtually unobtainable.

May's *Diseases of the Eye*, now in the 22nd edition, is still "the best *vade mecum* and all-round general text that we possess." Despite the existence of several texts on ocular pathology from the optometric viewpoint, we are still in absolute agreement with the statement quoted for the purpose under consideration. Sheard pays tribute to Fuchs and Roemer and Haab, and we would add Duke-Elder, but what optometrist would really need these for his practical library? And the famous Oatmann *Fundus Oculi* slides now cost $35 or more per set—if you can find them at your rare book dealer's. Perkins and Hansell's *An Atlas of Diseases of the Eye* (Little-Brown) is a good review text.

Javal's *Strabisme* (in French) and Worth's *Squint* are the recommendations under "Squint or Strabismus." Although there is now a considerable literature on this subject, Worth's, now in the ninth edition and edited by Lyle (Bailliere, Tindall, and Cox) would still be our first choice in this category.

The only suggestion under "Perimetry" is Peter's *Principles and Practice of Perimetry*, plus the statement that it "will repay the reader if he indulges in a second or third reading"! Our offering would be Harrington's *Visual Fields* (Mosby), although Traquair's *Clinical Perimetry* is also a good text on this topic (7th ed., Mosby).

Back in 1918, "one of the modern methods of diagnosis in ocular examinations lay in blood pressure"! We simply won't comment here.

Dr. Sheard closes his WELLSWORTH article with a plug for the famous *American Encyclopedia of Ophthalmology*, still incomplete at the date of his writing. As nothing has ever come along to replace it, except perhaps Duke-Elder's *Textbook of Ophthalmology*, which is far too expensive for the average individual's library even if it were obtainable, let's be content with suggesting a good specialized dictionary, now that it has finally appeared—Schapero's *Dictionary of Visual Science* (Chilton). Curiously, Dr. Sheard did not mention Lewis' *Ophthalmic Dictionary*, which had even then run through many editions.

The horizons of optometry have expanded in several directions since Dr. Sheard's advice was given to eager practitioners so many years ago. No one was prescribing contact lenses then, for example. Today's doctor may prefer one of the encyclopedic services in this fast moving field, but we feel that Bier's *Contact Lens Practice*, second edition, is the best single text available (Butterworths).

As specialties have been recognized in the profession, a new genre of books is beginning to appear. We think especially of *Preschool Vision* by Apell and Lowry (AOA); the optometric symposium on *Vision of the Aging Patient* edited by Hirsch and Wick (Chilton); and Hofstetter's *Industrial Vision* (Chilton). Undoubtedly, the future will produce many others. On the practice management question is Barstow's *How to Succeed in Optometry*, second edition (ICO Press). Holmes' *Guide to Occupational and Other Visual Needs* (Association of Independent Optical Wholesalers) has many practical applications. A new book by Bier, *Correction of Subnormal Vision* (Butterworths) has just been published.

None of these aspects of optometric practice were considered in the books recommended by Dr. Sheard. But times change, and the profession must reshape itself. The curricula of our best optometric colleges undergo constant revision. The notes and manuals and texts collected during his schooling by each new graduate of course become the nucleus of his professional library. Soon, however, he will need to bring his collection up to date. Part of the qualification of a professional man is the recognition within himself that there is so much more to learn, and the will to do something about it. The development and use of a personal professional library is surely one evidence of continued professional growth.

Part of the satisfaction and fun in building a personal library is the recognition of one's own point of view from which to start, and the following or not following of byways down which one is tempted to wander. Dr. Sheard was suggesting a basic collection for the optometrists of that day. Because we are attempting a modern parallel, our selection may seem *too* basic to some readers—too elementary. If so, specialize in one or more subject fields. There are so many more "eye" books available today that one could build quite a respectable collection on glaucoma, for example, perhaps beginning with Sugar's *The Glaucomas*, second edition (Hoeber-Harper).

Our optometric journals all have book reviews or abstracts, so keeping up on what's available is not too difficult. You can ask to be

placed on the mailing list of those publishers specializing in vision books. And many jobbers furnish *Medical Books in Print* under their own imprint. The current issue lists 134 items under "eye," many of which are of interest to optometrists.

Selection for one's personal library should be based on: *usefulness, personal interest,* and *reputability* (of author and publisher), with due attention to *cost* and *recency.*

One final word. Binding your professional periodicals makes them an integral part of your library, and reduces storage problems while keeping the material readily available.

Dr. Sheard's selections have almost all remained as "classics" of optometric, optical and ophthalmological literature—a tribute not only to his perception but to his taste. A few of the modern counterparts seem to show something of that stature that marks a classic—even if we usually have to recognize such in retrospect. Another forty years should tell!

So here are our suggestions for a relatively well balanced but minimal professional library, give or take a few items as one's personal interests dictate. We certainly don't expect complete agreement, but we hope you'll find them "well worth" consideration, and "think-making," too.

BOOKLIST FOR A SMALL PROFESSIONAL LIBRARY

(Lists only books mentioned in the text which are in print and obtainable at the date of writing.)

Blakiston's New Gould Medical Dictionary. 2nd ed. Blakiston-McGraw, 1956.

Goss, Gray's Anatomy of the Human Body. 27th ed. Lea & Febiger, 1959.

Ruch, Theodore C., and Fulton, John F. (formerly Howell's), Medical Physiology and Biophysics. 18th ed. Saunders, 1960.

Houssay, Bernardo A., et al., Human Physiology. 2nd ed. Blakiston-McGraw, 1955.

Southall, James Powell Cocke, Mirrors, Prisms, and Lenses. 3rd ed. Macmillan, 1933.

Fincham, W. H. A., Optics. 6th ed. Chilton, 1954.

Jenkins, Francis A., and White, Harvey E., Fundamentals of Optics. 3rd ed. McGraw-Hill, 1957.

Borish, Irvin M., Clinical Refraction. 2nd ed. Professional Press, 1954.

Manas, Leo, Visual Analysis Handbook II. 2nd ed. Professional Press, 1958.

Giles, George Henry, Principles and Practice of Refraction. Chilton, 1960.

Kozol, Frank, Ophthalmic Fitting and Adjusting. Chilton, 1958.

Stimson, Russell L., Ophthalmic Dispensing. Educational Foundation in Ophthalmic Optics, American Board of Opticianry, 1951.

Smith, William, Clinical Orthoptic Procedure. 2nd ed. Mosby, 1954.

Sheard, Charles, The Sheard Volume—Selected Writings in Visual and Ophthalmic Optics. Chilton, 1957.

Perera, Charles A., May's Manual of Diseases of the Eye. 22nd ed. Williams and Wilkins, 1956.

Harrington, David O., The Visual Fields—a Textbook and Atlas of Clinical Perimetry. Mosby, 1956.

Scott, G. I., Traquair's Clinical Perimetry. 7th ed. Mosby, 1957.
Apell, R. J., and Lowry, R. W., Jr., Preschool Vision. American Optometric Association, 1959.
Hirsch, Monroe J., and Wick, Ralph E., Vision of the Aging Patient, an Optometric Symposium. Chilton, 1960.
Hofstetter, Henry W., Industrial Vision. Chilton, 1956.
Barstow, Ralph W., How to Succeed in Optometry. 2nd ed. ICO Press, 1959.
Holmes, Clark, Guide to Occupational and Other Visual Needs. Association of Independent Optical Wholesalers, 1958.
Perkins, E. S., and Hansell, Peter, An Atlas of Diseases of the Eye. Little, Brown, 1957.
Bier, Norman, Correction of Subnormal Vision. Butterworths, 1960.
Spooner, J. D., Ocular Anatomy. Hatton Press, 1957.
Bartley, S. Howard, Principles of Perception. Harper, 1958.
Sugar, H. Saul, The Glaucomas. 2nd ed. Hoeber-Harper, 1957.

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BOOK REVIEW

OPTICS. An Introduction for Ophthalmologists. Kenneth N. Ogle, Ph.D., head, Section of Biophysics; Consultant in Visual Optics to the Section of Ophthalmology, Mayo Clinic. Professor of Physiological Optics, Mayo Foundation and Graduate School, University of Minnesota. Published by the Charles C. Thomas Co., 301-327 East Lawrence Avenue, Springfield, Illinois. 265 pages. Illustrated. Cloth. $8.75. 1961.

The basic science of optics, though a part of the curricula of both Optometry and Ophthalmology, often lacks the glamour of the clinical subjects, at least in the minds of students. Many of them seem to feel it sufficient to leave problems of optics to the shopman, while they concentrate on the treatment of patients. Actually a knowledge of optics is highly important for optometric and ophthalmologic practitioners. The subject should be emphasized much more than it is.

Optics are often considered by students to be their hardest subject because of the lack of motivation in some courses, the use of cumbersome and wordy texts and the overpowering attraction of clinical matters. Dr. Kenneth N. Ogle, head of the Section of Biophysics, Consultant in Visual Optics and Professor of Ophthalmological Optics at the Mayo Foundation and the Graduate School of the University of Minnesota, has brought out a book intended to meet the needs of students.

A new book on optics is not unusual but an easily understandable

one is. Such a book is Dr. Ogle's *Optics*. It is an introduction to the subject, aimed at preparing the student for the study of the refraction of the eye, physiologic optics and visual physiology. It is clearly and directly written. Subjects which, in other texts, are often hedged about with mathematical verbiage are brought down to earth and clarified. The areas likely to be involved in the problems of practitioners are somewhat emphasized and at the same time many irrelevancies, at least for this group, are eliminated. Its fourteen chapters cover a range from the physical characteristics of light through refraction, lenses, lens combinations, ophthalmic optics, optical instruments and the principles of illumination.

The book presents a profusion of diagrams, all clearly defined and well conceived. A section of exercises and a list of references appear at the end of each chapter so that the student can try his knowledge and read further into the subject. Other books recommended for collateral or supplementary reading are given in an appendix. This reviewer intends to put the book on the reference list in one of his courses at Boston University. Although written for students it should also prove useful as a refresher for practitioners.

THOMAS H. EAMES, ED.M., M.D.

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NEW BOOKS RECEIVED

CORRECTION OF SUBNORMAL VISION. Norman Bier, F.B.O.A., (Hons.) F.A.A.O., D.Orth. Published by Butterworths (London). Agent in the U.S.A., the George Eliot Medical Book Co., 1302 Second Avenue, New York 21, N. Y. 244 pages. Illustrated. Cloth. $10.00. 1960. By the author of *Contact Lens Routine and Practice*.

INSTRUMENT REVIEW

APEX PRECISION THICKNESS LENS DIAL GAUGE

G. M. Carlson of the Apex Specialties Company announces the introduction of a new Apex Precision Thickness Lens Dial Gauge for accurate checking of the thickness of all types of rough, semi-finished and finished ophthalmic lenses. See Figure 1.

Fig. 1.

The readings are shown on the dial in one-tenth millimeters. The gauge registers up to 10 millimeters. The gauge may also be of value in some forms of contact lens production work. The gauge is quick acting and has adjustable points for resetting. Additional information may be had by writing the Apex Company, 1115 Douglas Avenue, Providence 4, Rhode Island.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

VACATIONS AND CONVENTIONS

The Canadian Association of Optometrists will hold its annual meeting in Halifax, Nova Scotia, July 9-12, 1961. The local committee are sending 1,500 special invitations to Canadian members and a large turnout of members and wives is expected. The list of speakers will be announced later but the entertainment features for the convention include the following: deep-sea fishing; a yachting cruise; a power boat cruise; swimming; a visit to the Citadel Hill Museum; a special musical; several luncheons with entertainment; drives to historical points; a cocktail party; a lobster dinner; a dance—country style; a cruise on a modern destroyer with tea at sea, and of course a banquet. It seems hardly possible that there will be time for speakers but we are assured there will be—as well as time for the business meetings of the Association. Optometrists from overseas and the U.S.A. will be welcome as guests and further information may be secured by writing Dr. Ronald Wallace, Wallace Building, Grandville at Blowers Street, Halifax, Nova Scotia, Canada.

The annual Congress of the American Optometric Association is scheduled at the new Hilton Hotel, Denver, Colorado, June 17-20, 1961. At the time of preparing the copy for this department we had not been advised of the general program that will, of course, be built around the various meetings of the House of Delegates of the A.O.A. which will be in session for much of the four-day period. We hope to mention the highlights of the A.O.A. program next month.

For optometrists who enjoy including conventions in their vacation trips, the annual meetings of the A.O.A. and the Canadian Optometric Association are certainly to be recommended. Each convention will be held in an ideal vacation area. The A.O.A. in the mountains in June. The Canadian Optometric Association at the seaside in July. This is the time to get out the road maps and sit down with the family and plan another of those never-to-be-forgotten vacations.

SOUTHERN COLLEGE OF OPTOMETRY

Dr. Henry N. Peters, Jr., has been appointed to the faculty of Southern College of Optometry, Memphis, Tennessee, where he will

teach courses in basic optometry and instruct in the clinical clerkships. Dr. Peters holds Bachelor of Science and Doctor of Optometry degrees from Southern College and a Bachelor of Arts degree from Southwestern at Memphis. He has been in practice in Memphis since his graduation from Southern College in 1956. He is a member of the American Optometric Association and the American Academy of Optometry. He has been chairman of the public relations committee of the West Tennessee Optometric Society since 1956, and was secretary of the society from 1956 to 1959 before being elected in 1959 to his present office of vice president.

PACIFIC UNIVERSITY

A $10 million expansion program was announced for Pacific University here today by its president, Dr. Miller A. F. Ritchie, as climax of a Founders Day celebration. The new development, projected for 10 years, will include additions to the present library, women's dormitory, and College of Optometry buildings. Other improvements will be a new men's dormitory, athletic field house and swimming pool, science building, student center, and chapel-auditorium. Present buildings also will be renovated. The 112-year-old institution, one of the oldest on the Pacific Coast, also adopted a statement of new purposes, and basic policies of operation affecting students, faculty, administration, and the community.

NAVY OFFICER PROCUREMENT POLICY CHANGE

It is now possible to obtain a direct commission in the optometry section of the Navy Medical Service Corps. In effect, this means that successful optometric candidates will not, as in the past, be required to attend the officer candidate school, Newport, R. I., for four months' indoctrination. Instead, they will receive orders as commissioned officers to the U. S. Naval School of Hospital Administration, National Naval Medical Center, Bethesda, Md., for a one month period of basic indoctrination prior to assuming professional duties. Only applications for active duty are desired.

Information and fact-filled brochures may be obtained from the nearest Navy Recruiting Office listed in the phone book or by writing to Chief, Bureau of Medicine and Surgery, (Attn.: Code 35), Department of the Navy, Washington 25, D. C. Optometrists seeking new horizons, professional challenges, and a desire to serve their country, will find a rewarding career in the optometry section of the Navy Medical Service Corps. If you are a graduate or potential graduate in the senior class of an approved Optometry School, college or university,

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NEW I.E.S. GUIDE TO HOME LIGHTING

Lighting . . . Keyed to Today's Homes is the title of a new publication of the Illuminating Engineering Society which provides a practical guide to combining and enhancing fashionable home decor with correct light for living and seeing. Written in layman's language, but in every way compatible with I.E.S. lighting and vision recommendations, this new report of the I.E.S. Residence Lighting Committee carries full Society approval.

This attractively covered, full size book contains 88 easy-to-use pages, profusely illustrated with over 250 photographs and drawings, showing the newest in lighting design for residences. Sketches are used throughout to give construction and architectural details, with large, clear photographs to illustrate lighting effects at their best. *Lighting . . . Keyed to Today's Homes* gives answers to such questions as: Where do I place portable floor and table lamps? What type and design should I use? How big a bulb? What will my rooms look like with proper lighting? What about fluorescent lighting . . . over the fireplace or against the living-room ceiling, for instance? And hundreds of other problems encountered by home lighting people every day.

Included in the Appendix are: color chip and reflectance chart; wood reflectance chart; glossary of lighting terms; other references. *Lighting . . . Keyed to Today's Homes* has been designed specifically to give home lighting and related information to: architects, interior designers, home lighting specialists, landscape designers, teachers, optometrists, home demonstration agents, electrical contractors and electricians, manufacturers and distributors of home lighting equipment, as well as homemakers interested in proper lighting for their own homes. Copies are available at $1.50 each. Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

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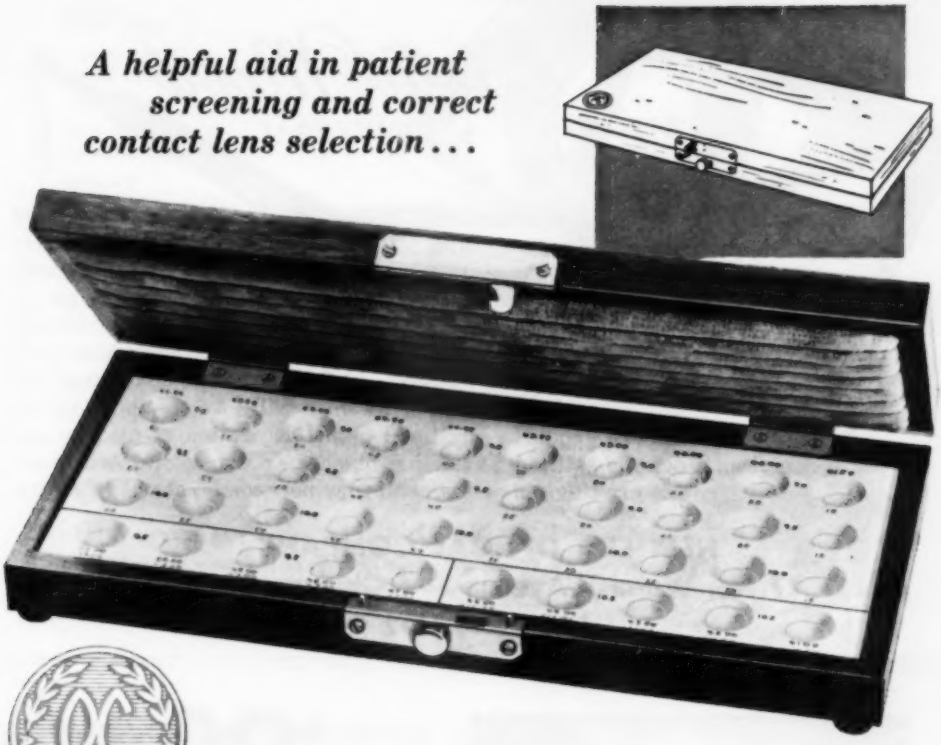

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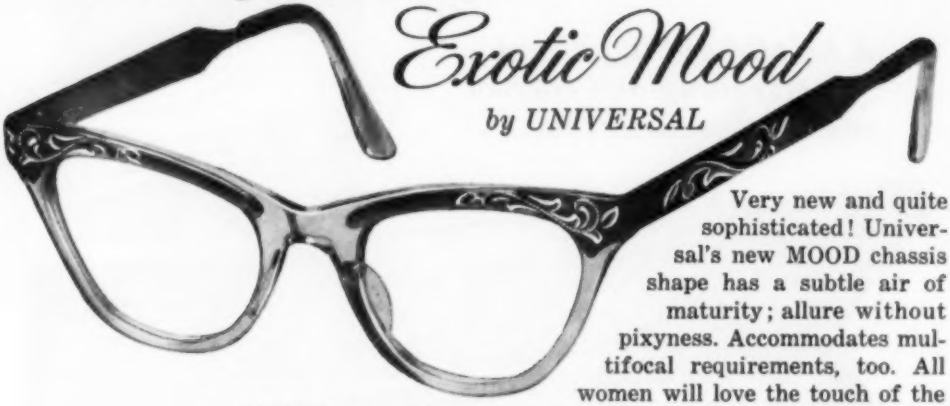

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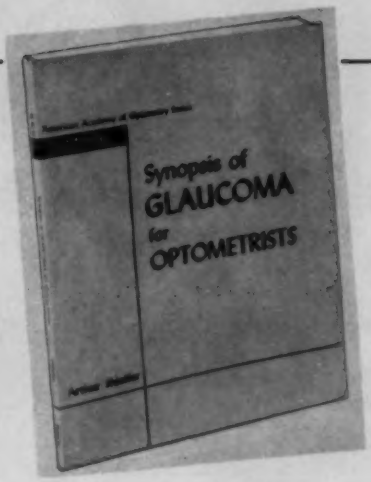

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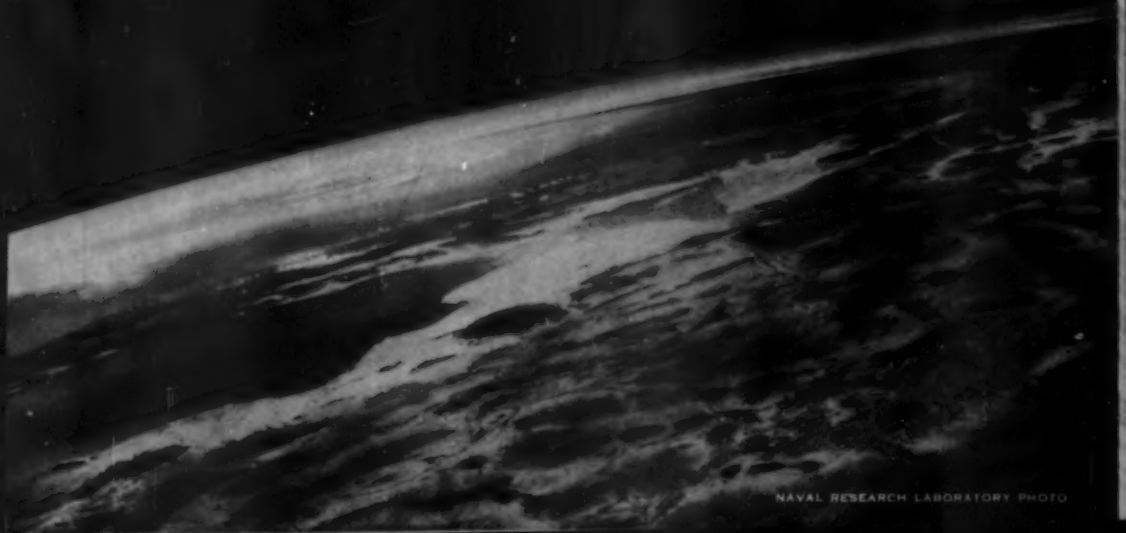

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